POWER

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The Use of Exhaust Steam

MUCH of the objection to the use of exhaust steam for dyeing and other processes is laid to its slowness.

The boss dyer says he lays a batch of goods upon the bench to wait for the bath to heat and it takes so long when exhaust steam is used that they get streaky before the tub is ready.

He seems to think that the heating power of steam is in proportion to its pressure.

Low-pressure steam, exhaust steam, carries almost as much heat per pound as steam of the pressures commonly used in its stead.

Whether it be high-pressure or low-pressure, hot or cool, the steam becomes water of the same temperature and pressure as that of the contents of the tub the instant that it comes into contact with them.

A pound of steam of atmospheric pressure would bring into a dye tub 1,150.4 heat units and, if the contents were at 70 degrees, liberate enough heat to raise each thousand pounds of water 1.11 degrees.

A pound of steam of 50 pounds gage would bring in 1,178.5 heat units and liberate enough heat to raise each thousand pounds of water 1.14 degrees, a difference of only three one-hundredths of one degree even if the exhaust steam has no pressure above the atmospheric and the live steam 50 pounds.

If the exhaust steam has a gage pressure of 10 pounds and the live steam 35 pounds, the difference will be only a little over one hundredth of a degree per pound.

But the volume of a pound of steam at atmospheric pressure is almost a cubic yard while the volume of a pound of 50 pounds steam is less than 7 cubic feet.

Furthermore, there is little difference in pressure to push the steam of about atmospheric pressure into the liquid, while with the live steam there is considerable moving force, so that one has to force a considerably less volume of the higher-pressure steam into the tub to get the same heating effect. Through the same opening this will require less velocity, and it has the punch behind it to give it what velocity it needs.

But if the pipes and passages conveying the exhaust steam are made sufficiently large to take care of its greater volume, only a moderate back pressure will be needed to force as many heat units per second into the operation as are required.

One method is to bring the exhaust steam to the tub in a generous sized header and lead from that header a number of feeders into the bath. When these are all open, a large volume of steam enters and heats the contents quickly. As the desired temperature is reached, most of the valves are closed, leaving only one or two open to maintain and regulate the temperature.

It seems absurd to put 1,100 to 1,400 heat units into a pound of steam, convert 15 or 20 per cent of it into power, throw the rest into the river and then run other boilers to do heating and process work that with a little attention to such details the wasted heat could do at the required temperature level with a combined thermal efficiency approaching 100 per cent.

Welded Pipe Joints for Power Plants

By EUSTIS H. THOMPSON*

ALTHOUGH fusion welding occupies an important position in the power plant for miscellaneous repairs and is applied to a less extent for fastening nozzles and minor piping work, welded joints for pressures of 200 lb. and upward have until recently made comparatively slow progress. This does not refer to the type of joint in which welding unites bolted flanges for purposes of steam tightness, but to the line weld as used instead of a flanged connection.

On one hand, there is the feeling that much depends on the welder, and from the fact that the quality of his work is subject to variation, many engineers refuse to place reliance upon gas- and electric-welded joints for high pressures. Regarding the other side of the question, plants are now in operation up to 300 lb. pressure employing welded joints practically throughout. In some instances welding has been successfully applied over periods of ten years or more for pressures around 200 lb. The desired reliability has been well secured, and at the same time certain definite advantages of welded joints realized.

MANY years of service have in some instances demonstrated both the reliability and advantages of welded pipe joints. An article to follow will describe the practice at the Westport Station of the Consolidated Gas, Electric Light & Power Co.

While the cost of such joints compares favorably with bolted, especially in the larger sizes, the greatest saving appears to be in the matter of time and convenience in erecting or making changes. If a large auxiliary drive is to be substituted for a smaller one, requiring a change in the steam connection, it is usually a matter of but a few hours to cut the steam line, insert nipples, bends, etc., and to align before welding at the joints. The great time and care required in many instances for laying out and fabricating a connection and additional fitting on the job may be thus eliminated. Besides, the uncertainty of delay incident to correcting mistakes of detailing is thus avoided.

Where complicated steam piping must be changed, involving a long period of repair, part of the work at a time can be done conveniently by welding during the weekly shutdown periods. Temporary connections are easily put in so that all spare time is utilized to best advantage. Time and painstaking accuracy, ordinarily required in designing bolted connections, can be dispensed with to an appreciable extent.

Large steam connections of difficult shape, when constructed by welding straight pieces and sections of standard bends, are often less costly than when fabricated. Alignment can be taken care of by adjustment at the welds, and saving in freight is sometimes appreciable.

Salvaging of left-over material is another point that must not be overlooked. Odd lengths of pipe, pieces of bends, even piping of different diameters may readily be connected up into a workable line. A drain may be inserted without special fittings or restriction as to diameter by using the most available material and welding in at the point desired.

In comparison with bolted flanges a pipe line is made appreciably lighter and more uniform by the elimination of such joints as far as is consistent. The cost of heat-insulating material and labor is much less, and appearances are improved. These comparisons become more marked for conditions of high pressures and temperatures. Reinforced welds utilize material more efficiently and increase comparatively less in bulk as conditions become more adverse.

Tightness, when once obtained in a line weld, remains ordinarily as a permanent condition. The fact that such a joint when correctly installed is not subject to gasket deterioration, bolt stretching, etc., is an important factor with regard to general maintenance.

On the other hand, among the points of superiority of bolted flanges, first of all comes convenience of separation. Where joints must be opened at intervals for purposes of maintenance, inspection, inserting an orifice, checking alignment, etc., the flanged joint is ordinarily conceded to be more desirable. Welded pipe installations as a rule provide bolted connections in preference to welded, for valves, machine flanges, and at other points likely to require separation.

Butt welds are not as rigid as flanged connections. Although there is no practical and dependable method of measuring the exact margin of safety in a welded joint—which is true in some degree of a riveted one—such a joint when properly executed may be made as strong and rigid as the pipe itself, and more so if desirable. Under such conditions it is amply sufficient for pipe work, and instances exist of its application at pressures and temperatures exceeding the present maximum steam conditions for severity.

The problem of obtaining reliability in spite of the fact that a welder's work is ordinarily subject to variation in quality, has been satisfactorily met in many power installations. The ultimate strength and quality depend upon several factors. By laying down conditions which, if carried out efficiently, would result in a definite safety margin, it is possible to allow for reasonable shortcomings in the welder's work or in any other direction. Besides, suitable tests can be made to check actual conditions. It has been found possible in this way to obtain the desired degree of reliability, with the result that welding is now being applied to an increasing extent.

Reliability in welding, like that of many other processes, depends on several factors or conditions. If each of these bears its fair share of the burden, the final result will be a joint considerably stronger than the material so attached. This chain of requirements

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has been described by S. W. Miller[1] and G. O. Carter.[2] Its application in the plant to pipe work appears to consist of ten links, as hereinafter briefly outlined:

1. Welding Must Be Sold to the Management—The process requires close executive attention. A welding crew cannot be expected to operate satisfactorily without interested supervision.

2. Design of Joint—Strength exceeding that of the pipe should be arranged for. The deposited metal may be specified as superior in strength to the base, or reinforcing may be added. Butt welds are best made with 45-deg. bevels at each side, giving an included angle of 90 deg., as at Fig. 5. A thickness of $\frac{1}{16}$ in. should be provided from the apex of the groove to the inside of the pipe, as shown.

3. Rod Material—The requirements of strength of the welding rod have been referred to in the preceding paragraph. The rods, however, should be as like the metal to be joined as possible. For pipe work, therefore, low-carbon steel is usually preferred, which may be annealed easily.

4. Pipe Material—Chemical analysis is not usually a sufficient criterion of quality. Dirt or other foreign material that is not located by such a test tends to separate out from the crystalline metallic structure, as hereinafter described, providing a weak layer conducive to failure. Tests to determine this condition are difficult. The desired grade of material is usually purchased on the guarantee of a reliable manufacturer in a similar way that "firebox" quality steel is supplied. For ordinary pressures and temperatures, however, the usual piping material is sufficient.

5. Selecting the Welder—Since this work entails much responsibility, a welder should be chosen on the basis of experience, character, skill, etc., in the same way that an equally responsible position would ordinarily be filled. Before undertaking any welding, the man should be given a test under conditions as encountered and not others remotely connected therewith. When placed in regular service, a certain proportion of the welds made should be cut up and examined for porosity, tensile strength, etc. Welded test specimens or coupons may also be required from time to time. This is for the purpose of maintaining as uniform a product as possible.

6. Preparation—Surfaces to be joined should be absolutely clean and in accurate alignment, held by suitable clamps or otherwise, the correct separation being about one-half the pipe-wall thickness. Distortions must be gaged and allowed for. Torch, rods and miscellaneous equipment should be convenient and in good condition.

7. Procedure—Actual welding procedure varies with the work in hand. In general, large joints should be first tacked together with bridges at intervals to counteract strains of expansion; melting away some of the first metal deposited and then rewelding may be necessary.

8. Annealing—Internal strains may be removed and the internal structure of both the low-carbon steel weld metal and pipe normalized by heating to 1,400 or 1,600 deg. F., with slow cooling. About 900 deg. relieves internal strains, but higher temperatures are required to restore the metallic structure. This should be done after making the butt weld. With some types of reinforcing, it is desirable to omit further anneal, so that the reinforcing will normally carry the greater stress.

9. Testing—It is customary to apply a hydrostatic test of two and preferably three times the working steam pressure. While the testing pressure is on, the welded metal is usually hammered severely. If water penetrates in any degree whatever, the entire weld may be renewed. Frequently, patching is resorted to, but it is not so thorough a remedy. Steam pressure is better applied through a bypass and slowly built up, while examining for leaks. Reinforcing, if possible, should be applied after this test is satisfactory. Under conditions of lower pressures the hydrostatic test is frequently omitted and steam pressure tried only.

10. Placing in Service—Much contraction may take place on cooling after welding. This should be allowed for in flexibility of design, by disconnecting and then checking the pipe length accurately and making corresponding adjustment, or by any other adequate means. Covering is applied preferably after a short service test.

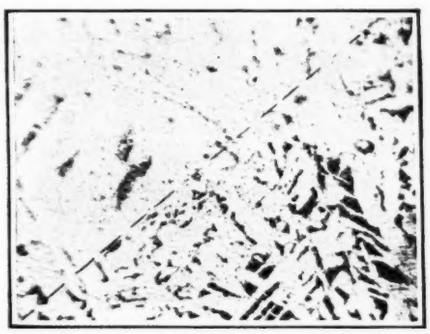


Fig. 1 — Micrograph showing weld metal at left of dotted line unites perfectly with base metal at right, (100 ×)

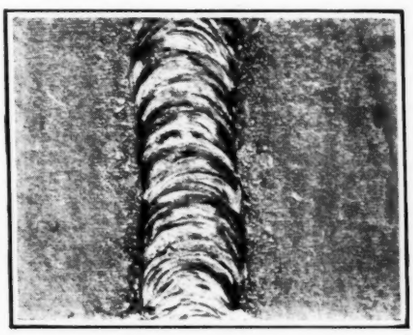


Fig. 2—Exterior of oxyacetylene double-V weld in half-inch steel plate, giving uniform fusion

Fig. 3—Line A in a one-half inch plate formed by impurities rejected to grain boundaries in poor quality steel (430 ×)

The internal structure of a weld may be gaged from the micrograph, Fig. 1. The dotted line shows the location of the union of weld metal and base metal, both of which are high grade, giving a perfect fusion. The exterior of a fusion weld appears in Fig. 2. The section micrograph, Fig. 3, shows at *A*, what may be taken for the line of union between deposited metal and an original surface. This line *A*, however, is caused by impurities separating out of the crystal structure, the actual union being somewhat to the left. With good quality plate this trouble does not exist.

[1]Of the Union Carbon and Carbide Research Laboratory, in "Some Principles of the Construction of Unfired Pressure Vessels," presented at the Atlanta meeting of the A. S. M. E., May 8, 1922.

[2]Consulting Engineer, Linde Air Products Co., in an article, "Importance of the Managerial Understanding of Welding," which appeared in *The Iron Age*.

From the appearance of the structure in Fig. 1 it may be inferred that a true weld is at least as strong as the metals composing it, which is borne out by tests. With full penetration the surface of fusion is greater than the sectional area of the original metal, and therefore the joint tends to be stronger in tension than the original metal. In ordinary tests an average welder's work should show 40,000 lb. per sq.in. and that of a good operator, 50,000 or above.

Since many are less accustomed to the mechanical requirements of welding than riveting, it appears that some tendency exists to regard a welded joint as insufficient in itself if trouble occurs, whereas defects of riveted seams are usually traced to faulty workmanship or material, and these latter factors duly held responsible. With proper supervision welding has demonstrated itself as satisfactory; in fact, for service at pressures and temperatures around 500 lb., 800 deg. F. or above in some special cases. Some stations utilizing fusion-welded joints are listed in the table.

The angle of bevel and thickness at the groove bottom for a butt weld are given in Fig. 5. A reinforced joint consisting of a split sleeve, fastened over a butt weld, appears in Fig. 4. A spot-welded joint, Fig. 6, contains a sleeve, perforated at several places, these holes being filled with welding metal acting to fasten on the sleeve, the latter also being welded at the ends.

Reinforcement by longitudinal strips is shown at Fig. 7. After making a butt weld, several strips are fastened at intervals lengthwise across it by fusion at one end. Each may be heated a definite amount and then fastened at the other end, so that in cooling, tension may thus, if desired, be taken up by these strips.

In Fig. 8 one pipe end is belled out and shrunk over the other. The countersink holes are spot-welded. These spots are in shear, giving a large margin of safety to resist pressure stresses. A circumferential weld is added. Fig. 9 is a shrunk sleeve welded at each end, and Fig. 10 a loose sleeve whose clearance over the butt weld is filled with welding metal. The "stovepipe" type of joint is shown as applied at Fig. 11, where relief valves are connected to a header.

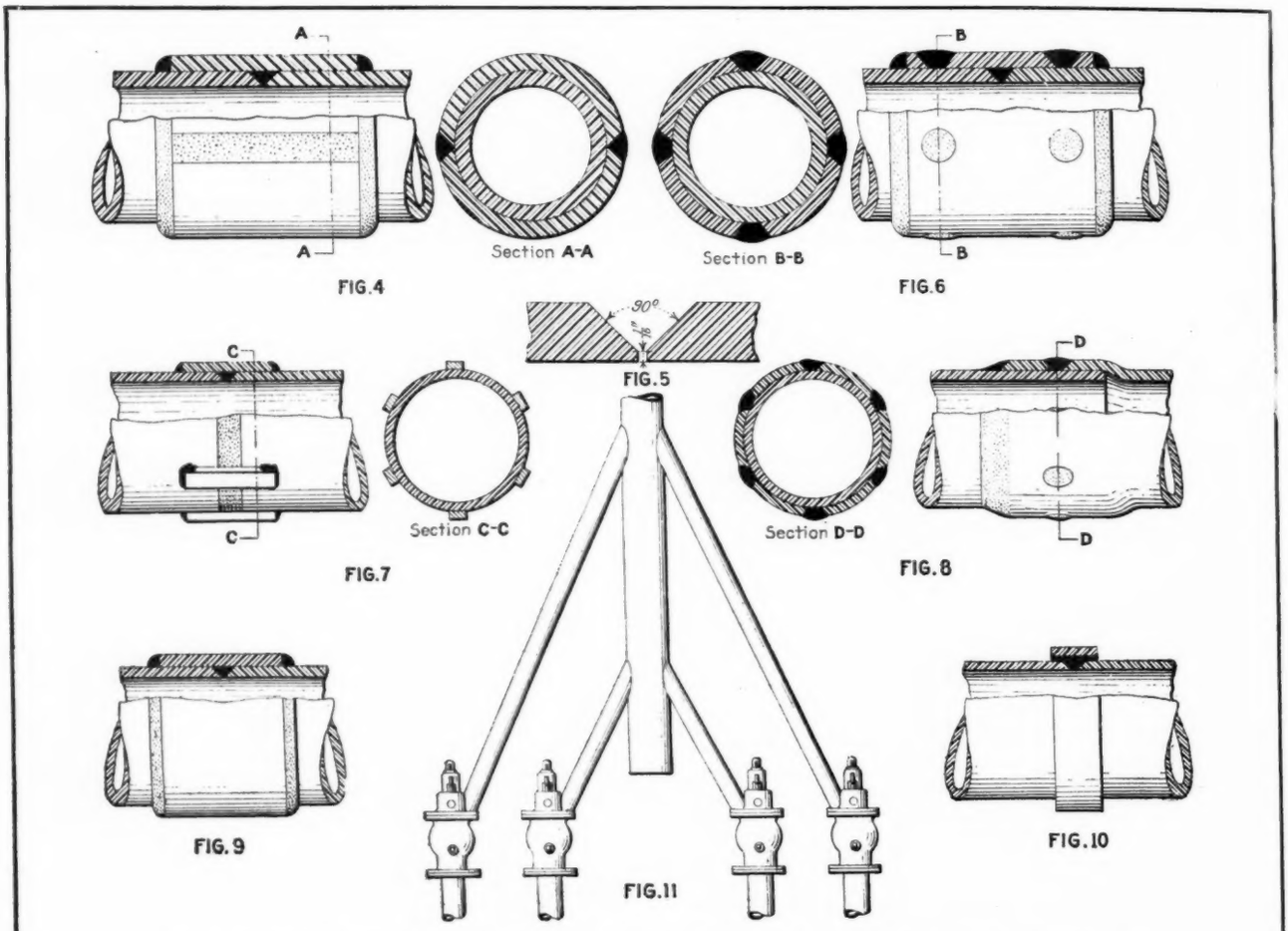


Fig. 4 to 11—Types of fusion-welded joints. Reinforced are, Fig. 4, split sleeve; Fig. 6, spot-welded sleeve; Fig. 7, strip-fastened; Fig. 8, shrunk and spot-welded lap; Fig. 9, shrunk sleeve and Fig. 10, metal-filled sleeve. Correct bevelling shown Fig. 5 and "stovepipe" joints, Fig. 11

SOME STATIONS UTILIZING FUSION-WELDED MAIN-PIPE JOINTS

Name of Station	Name of Company	Location	Rated Pressure, Lb. per Sq. In. Gage	Rated Temperature Total Deg. F.
Westport	Consol. Gas, Elec. Lt. & Power Co...	Baltimore, Md.	200	700
Duncan	Southern Power Co.	Duncan, S. C.	300	570
Industrial Plant	Victor Talking Machine Co.	Camden, N. J.	175	538
Steam-Heating Dept	Cleveland Elec. Illuminating Co...	Cleveland, O.	250	400
Rochester	Rochester Gas & Elec. Corp.	Rochester, N. Y.	220	550

The Flooded System of Operating Ice Tanks

By TERRY MITCHELL

ONE of the essentials of all up-to-date methods for making ice is the flooded freezing system. Without the economies made possible by flooded operation of the tank coils, the industry would not have grown to its present proportions in so short a time.

A glance at the illustration, Fig. 1, will make clear the principles involved in the flooded system. The liquid ammonia from the receiver passes through the expansion valve and enters the liquid header, which is placed at the bottom end of the tank coils instead of at the top. The liquid line divides just below the expansion valve and connects with the header at points near its two ends. The header feeds the ammonia to the lowest pipe of each of the coils, which stand between the rows of cans in which the ice is frozen. The arrangement of the coils, especially their connection with the liquid and suction headers, is plainly shown.

The liquid ammonia is fed to the coils so rapidly that it cannot quite all boil off in passing through the pipes.

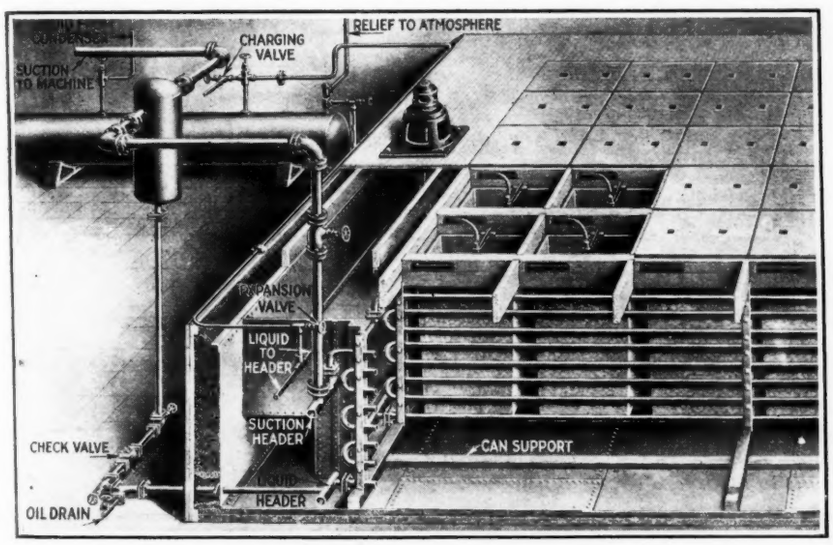


Fig. 1—Coil system with accumulator and bottom feed

If the pipes were of glass, the lowest one would be seen to be practically full of the liquid, the evaporated gas showing as small bubbles floating along the top side of the pipes. In each pipe higher up, the bubbles would increase in size until they occupied almost the entire cavity, enough liquid remaining to keep the surface of the pipe wet as the bubbles and liquid move along.

The action is somewhat like that of the air and water in the familiar air-lift system of pumping water from a well. At the bottom of the riser pipe the air bubbles are small, because of the pressure of the water, and though they expand greatly, there must always be enough water to form a seal between the bubbles, or the lifting effect on the water will be lost. The same enlargement of the bubbles is experienced with the ammonia, except that they increase in size more through evaporation of the surrounding liquid than change of pressure. The constant wetting of the walls of the pipes is one of the reasons for success of the flooded system, for it increases the transfer of heat from the brine in the tank to the ammonia in the coils over the transfer when nothing but gas fills the pipe.

The suction gas before passing to the compressor is put through what is called an accumulator; this is fitted with baffle plates for separating the ammonia liquid coming over with the vapor. This separation not only prevents the liquid from reaching the cylinders of the machine, where it would cause hammering, but makes possible the return of the excess liquid to the evaporating coils. The trapped ammonia drains from the accumulator through a 1¼-in. line into the liquid header. A check valve is inserted in the drain line to keep the ammonia from short-circuiting through the accumulator instead of following the longer path through the coils. The minimum height above the liquid header, at which the separator drum should be placed to give a good head for circulation of the liquid, is six feet.

A third function of the accumulator that is sometimes utilized is the precooling of the liquid as it passes to the tank, by means of spiral coils installed inside the accumulator shell. Excessive frosting-back on the refrigerating machine is thus prevented, at the same time increasing the effectiveness of the tank coils by supplying cold ammonia to them. This design is particularly advantageous in cases where there is no water forecooling tank through which the suction gas can be carried, to utilize the full cooling effect of the ammonia. Having the layout of the flooded system in mind, the benefits gained by operating the coils partly filled with liquid ammonia are apparent. The rate of heat transfer from the brine to the refrigerant is so much greater when the coils are flooded that a material saving is made in the amount of piping necessary or the time of freezing the ice may be reduced. There is no danger of having dry or superheated gas reach the machine, as the expansion valve can be adjusted to maintain the gas in a saturated condition.

With the flooded system the problem of steady operation and even temperature in the tank is solved. There is a good deal of liquid lying in the coils at all times,

and partial clogging or a poor setting of the expansion valve will not affect the system so quickly as when running with dry gas. An old freezing tank, if fitted with bottom feed for the liquid and with an accumulator, will have its capacity increased to a marked extent, and the machine will be able to take care of the larger capacity because the suction pressure can be raised. The better heat transfer tends to raise the suction pressure; the accumulator makes the higher suction perfectly safe, for any liquid coming over is caught before it can reach the machine.

Modifications of the flooded system include the substitution of a short liquid seal in the form of a double-bend gooseneck, in place of the check valve on the drain line for the accumulator. In some systems an ammonia pump is used to force the liquid into the high-pressure line instead of allowing it to run by gravity into the coils. The check valve gives the most positive protection against short-circulating the ammonia, and the pump requires additional power, so that standard practice is to arrange the system as shown in Fig. 1.

The piping and accumulator drum should of course be insulated for best results. In the plant shown in Fig. 2 there are two tanks and two accumulators. In plants where the ice tank is next to the ice storage or ante-room, it is good practice to install the accumulator inside the cold storage, thus saving the expense of insulating the drum and much of the suction and drain piping. The objection to this, of course, is that the ammonia headers and accumulator are usually placed at the opposite end of the tank from the ice dump and storage, so as to be nearer the machine and out of the way of the tank men.

This latter difficulty was gotten around in a clever way on a big job that went up recently in Los Angeles. The Crescent Creamery, a million-dollar installation, has two large ice tanks, each holding over a thousand cans. The suction lines from the coil headers were brought through the sides of the tanks, the pipes being made fast to the tank plates by welded joints. This arrangement left clear spaces for the dip tanks, dump and ice chutes. The suction lines extended into the daily storage room, where the accumulators and water forecooler were placed. The plant was so designed as to have the machines, which were four 12x12-in. inclosed-type compressors driven by 120-hp. natural-gas engines, conveniently near the daily storage.

The flooded system is also applied to tanks having shell-type brine coolers. There are no essential differences between the arrangement in this case and with the coils, except that a sort of telltale pipe is often connected to the cooler so as to be visible to the operator, the height of the frost on the pipe showing the level of the liquid in the cooler shell at any time.

Flooded operation is rarely attempted for the cooling coils of cold-storage rooms, owing to complications in the way of elevated connections for the accumulator, excessive ammonia in the pipes in case of leakage, slow transfer of heat from the goods through the air before it even reaches the coils, increased weight to be supported by the hangers and ceiling, etc. For brine or water cooling tanks and small ice-cream hardening rooms, an accumulator is often added for the sake of safety to the compressor as well as the better efficiency of the coils.

The rate of heat transfer from moving brine to ammonia is usually taken as 22 B.t.u. per square foot of surface per degree of temperature difference between the brine and ammonia, per hour in the flooded system. This is at least 10 per cent better than the transfer in a system where the suction is taken from the bottom pipe. In other words, a 20-ton plant could be expected to make from 22 to 24 tons of ice if changed to flooded operation. The extra increase would be possible because the suction pressure could be increased to the most efficient point for the plant in question without giving any cause for worry about dangerous pounding in the machine.

While alterations are being made to a plant, it is well to consider the addition of some more pipe surface to the tank coils, as better economy and considerably more ice can usually be secured in that fashion. Most cooling coils can have two new pipes inserted without much difficulty; the pipes can be staggered and each coil made eight or ten pipes high if the bends are not over 6 in. on centers and the tank is 4 ft. deep. Remember that by raising the suction pressure five pounds by gage, the capacity of your machine can be increased from 13 to 16½ per cent, while the power required for driving it will increase only 3 or 4 per cent.

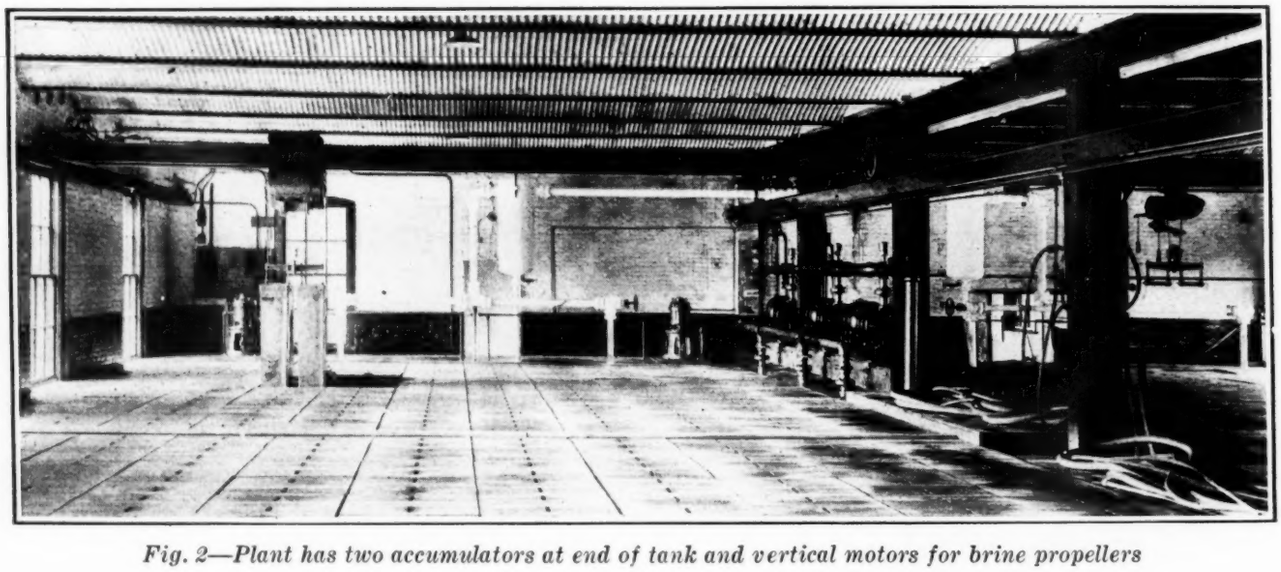


Fig. 2—Plant has two accumulators at end of tank and vertical motors for brine propellers

Getting the Most Out of Exhaust Steam

Advantages of Operating Heating System under Vacuum—Use of Bleeder Turbine—Hot-Water Heating

BY CHARLES L. HUBBARD

THREE methods for the utilization of exhaust steam in combined power and heating plants were considered in *Power*, April 14. These covered the use of a steam engine exhausting into the heating mains during the winter and operating non-condensing during the summer; the use of a turbine exhausting into the heating mains, with a condenser for summer operation; and the third case, where a condensing main turbine is used with heating steam supplied from an auxiliary turbine. In this article the Case 4 mentioned in the previous article will be discussed.

In the arrangement shown in Fig 1 the radiation is made to serve as a condenser up to its capacity for the engine, the surplus exhaust steam passing to a jet or surface condenser. While it is not possible to operate with a high vacuum upon the prime mover during the heating season with this method, the plant works condensing throughout the year, and no exhaust steam is discharged to the atmosphere. Referring to Fig. 1, *A* is a relief valve set to open automatically at a pressure of about 5 lb. abs. (20 in. vacuum); *B* a back-pressure, or relief, valve set to open at about 1 lb. gage; *C* a pressure-reducing valve for admitting live steam to the heating main when the pressure in the same falls below 5 lb. abs.; and *H* is a feed-water heater.

In operation, valves *A* and C automatically maintain

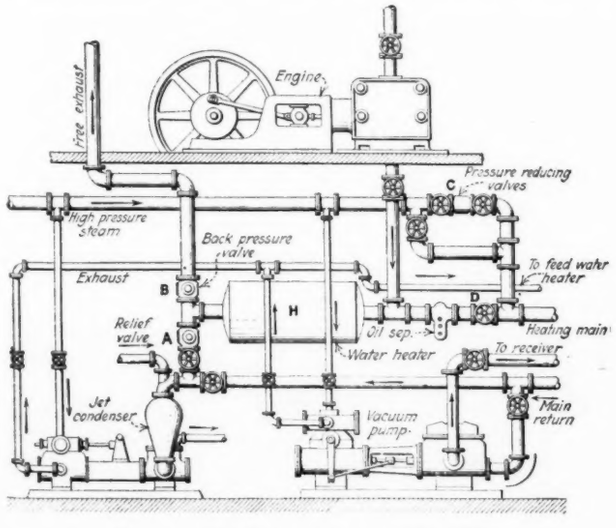


Fig. 1—Radiators act as condensers

a uniform pressure of 5 lb. abs. in the heating system, which is also the back pressure on the engine, regardless of the amount of steam condensed by the radiation.

In case all the exhaust steam cannot be condensed in the heating system, the pressure in the main will rise slightly, causing *A* to open and allow the surplus to pass into the jet condenser, upon which a vacuum of 26 to 28 in. is maintained. The gate valve *D* is closed during the non-heating season, and the engine is operated on a straight condensing basis. In case there is not sufficient exhaust at any time to hold a pressure of 5 lb. abs. in the heating main, the reducing valve *C* opens automatically and admits enough live steam to bring the pressure up to normal. In order to use this arrangement, the radiators must be connected up on the two-pipe system, with thermostatic valves on the return ends.

The main return is connected with the condenser

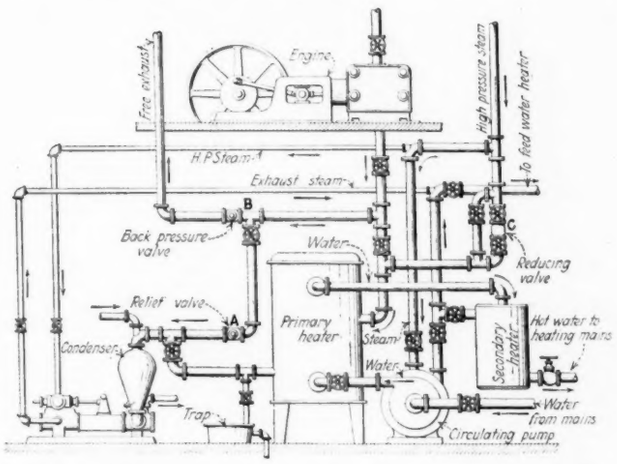


Fig. 2—Primary heater and hot-water system used

inside the valve *A* and is therefore under the condenser vacuum, thus giving an average pressure difference of $(27 - 20) \div 2 = 3\frac{1}{2}$ lb. between the radiators and the return lines. The vacuum pump is for use when the condenser is out of commission. Valves are also provided so that the radiation may be operated as an ordinary return-line vacuum system at any time desired. The exhaust from the auxiliary pumps is piped to a secondary feed-water heater, not shown in the drawing.

There is nothing complicated and little equipment is required over that for the usual condensing system.

With the back pressure assumed—that is, 5 lb. abs. or 20 in. of vacuum—the radiation will have a temperature of only 162 deg., as against 219 deg. at 2 lb. gage pressure, thus reducing the heating capacity to $(162—70) \div (219—70) = 0.62$ of what would be obtained under the usual conditions of exhaust-steam heating.

There are two ways of overcoming this, one of which is to increase the radiation about 40 per cent, which may sometimes be advisable in the case of new installations, while the other is to increase the back pressure on the engine during periods of extremely cold weather, when the heating power of the radiation is not sufficient at the lower steam temperature. Radiation designed for zero weather, with steam at 1 or 2 lb. gage, will overheat the buildings most of the time during the heating season, and much better results can be obtained by varying the pressure than by shutting off the radiation.

While it is true that raising the back pressure will reduce the steam economy of the engine, we may consider that the plant is being operated at a good over-all effi-

ciency so long as the heating is done entirely by exhaust steam and all surplus discharged into the condenser.

To obtain the highest economy, it is of course necessary to carry as low a pressure on the radiating system as will give the required heat for warming the buildings.

Let us now estimate the annual steam consumption for this arrangement, when applied to the problem assumed in the previous article, and see how it compares with Case No. 2, *Power*, April 14, where the plant was operated noncondensing for nine months of the year and condensing for three months, in which case the total steam consumption was 25,808,640 pounds.

As the heating plant is operated on the return-line vacuum system, with a pressure and temperature variation in the radiators, the steam consumption for different outside temperatures may be taken from the vacuum system curve in Fig. 4, and is as follows:

Month	Outside Temp., Deg. F.	Steam Condensed in the Heating System, per Hr., Lb.
January	20	6,400
December and February	30	5,600
November and March	40	4,800
October and April	50	4,000
September and May	60	3,200

Assuming a radiation system designed for a maximum condensation of 8,000 lb. of steam per hour at a gage pressure of 2 lb., the first step is to see what is the lowest back pressure that may be carried on the engine during the coldest month and give a sufficiently high radiator temperature to condense the required amount of steam for warming the buildings. January is shown with an average temperature of 20 deg. and requires the condensation of 6,400 lb. of steam per hour, which is 6,400 ÷ 8,000 = 0.8 of that required under maximum conditions with a back pressure of 2 lb. gage. The difference in temperature between the air of the rooms and steam at 2 lb. gage pressure is 219 — 70 = 149 deg. Hence, to condense 0.8 as much

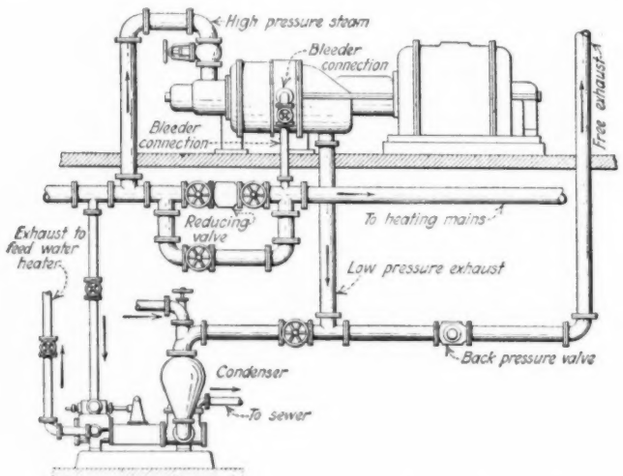


Fig. 3—Bleeder turbine used with heating system

steam, the difference must be 149 × 0.8 = 119.2, which calls for steam temperature of 119.2 + 70 = 189.2 deg.

This corresponds very closely to an absolute pressure of 9 lb., or 12 in. of vacuum. In like manner approximately 17 in. of vacuum may be used for an outside temperature of 30 deg. in December and February; 20 in. for a temperature of 40 deg. in November and March; 23 in. for a temperature of 50 deg. during October and April, and 25 in. for a temperature of 60 deg. in September and May. During the remainder of the year valve *D* will be shut and valve *A* opened wide, and the engine run under the full vacuum of, say, 27 in. If the plant is considerably spread out, it will be best to stop with a vacuum of 23 in. in the heating main, in order to give sufficient pressure difference

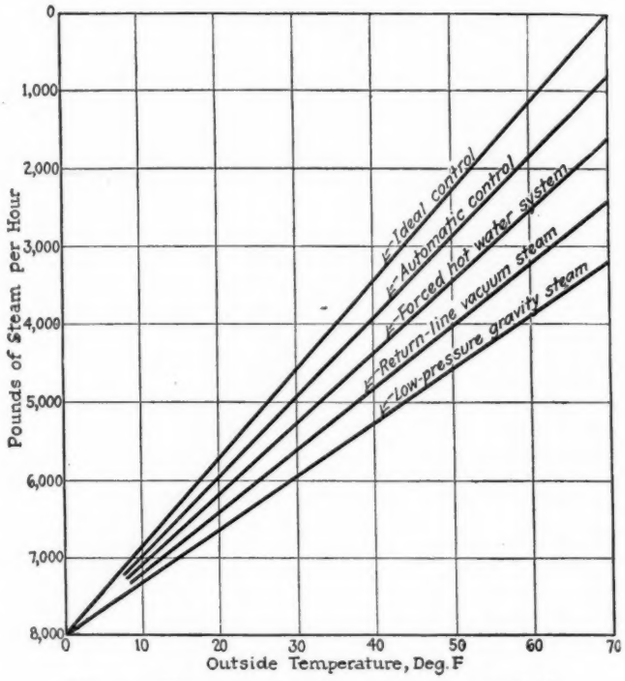


Fig. 4—Steam for heating at various outside temperatures

between the radiators and returns for proper drainage, and we will use this limit in the present case. Assuming a water rate of 24 lb. per indicated horsepower, non-condensing, and a reduction of 25 per cent for a 27-in. vacuum, it will give practically the following for different degrees of vacuum:

Vacuum, In.	Pounds of Steam per I.Hp. per Hr.	Vacuum, In.	Pounds of Steam per I.Hp. per Hr.
12	21.5	23	19
17	20.5	27	18
20	19.5		

During January, with an outside temperature of 20 deg., 6,400 lb. of exhaust steam per hour are required for heating the buildings. The available exhaust from an engine of 500 hp. operating under a 12-in. vacuum will amount to 21.5 × 500 × 0.85 = 9,137 lb., which is in excess of the maximum amount of steam required for heating. Assuming 188 working hours per month, as before, and tabulating the foregoing data, gives the following:

Month	Average Outside Temp.	Vacuum Carried In.	Pounds of Steam per I.Hp.-Hr.	Total Pounds of Steam for Month
September	60	23	19	1,786,000
October	50	23	19	1,786,000
November	40	20	19.5	1,833,000
December	30	17	20.5	1,927,000
January	20	12	21.5	2,021,000
February	30	17	20.5	1,927,000
March	40	20	19.5	1,833,000
April	50	23	19	1,786,000
May	60	23	19	1,786,000
June	70+	27	18	1,692,000
July	70+	27	18	1,692,000
August	70+	27	18	1,692,000
Total for year				21,761,000

Adding 2.5 per cent for operating the condenser pumps produces a saving of 25,808,640 — 22,305,000 = 3,503,640 lb. of steam over the method of running straight non-condensing during the heating season and condensing through the summer.

The equivalent saving in coal is approximately 3,503,640 ÷ (9.5 × 2,000) = 184 tons. When compared with running non-condensing throughout the year the coal saving amounts to approximately 184 + 60 = 244 tons. This of course, does not take into account the cost of cooling water or overhead charges on the cost of condensing equipment, but the saving is a substantial amount.

The layout for Case 5 is shown in Fig. 2 and is a modification of Case 4, adapting it to a system of

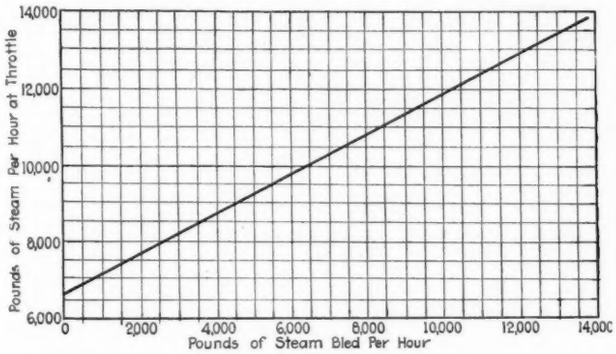


Fig. 5—Steam consumption of 300 kw. bleeder turbine

hot-water heating by forced circulation. The exhaust steam is turned into a primary heater, which is in reality a surface condenser, and heats the water which is circulated through the radiation. Here, as in Fig. 1, any deficiency of exhaust required to carry the heating load is made up by live steam supplied automatically through the reducing valve *C*, while the surplus exhaust, as the outside temperature rises, is discharged through relief valve *A* into the condenser. The exhaust from the auxiliary pumps is turned into a secondary heater for giving a higher temperature to the water, or it may be employed for heating the feed water, and the higher temperature for the circulating water obtained entirely by raising the back pressure on the engine.

The steam economy with this arrangement will be so nearly like that in Case 4 that no special study need be made of it. An inspection of Fig. 2 will show that the heating system may be operated entirely independent of the condenser by using either exhaust or live steam at a reduced pressure in the primary heater.

One of the simplest and most satisfactory arrangements is shown in Fig. 3 and will be called Case 6. It makes use of a bleeder or extraction turbine, in which just the necessary amount of steam for heating purposes is bled or extracted at the desired pressure (usually 2 to 5 lb. gage), so there is never any surplus exhaust to discharge to the atmosphere.

In principle, the bleeder turbine consists of a high-pressure element and a low-pressure element, mounted on the same shaft. Steam at boiler pressure is supplied to the high-pressure element and expanded down to the desired bleeder pressure; whatever quantity is required for heating is extracted from the exhaust chamber, while the remainder passes into the low-pressure element and is expanded down to the condenser pressure. A uniform pressure is automatically maintained in the bleeder chamber regardless of the quantity of steam withdrawn, by means of a special valve connecting the exhaust chamber of the high-pressure element with the supply chamber of the low-pressure element. When the pressure rises slightly in the bleeder chamber, owing to a diminution in the steam requirements, the governor causes the bleeder valve to open slightly more and admit a greater quantity of steam to the low-pressure machine.

When so much steam is bled that the low-pressure element fails to receive enough exhaust from the high-pressure section to carry its share of the load, the speed drops slightly, and this acts on a second governor, which admits sufficient live steam at a suitable pressure to the low-pressure machine, to supply the deficiency. One may consider the bleeder turbine as a combination of pressure-reducing valve and straight condensing turbine. In a majority of plants this is the most economical plan to be used, so far as yearly steam consumption is concerned.

Exhaust from the auxiliary pumps is used in this case for heating the feed water, supplemented by live steam through a reducing valve when necessary. Although steam for feed-water heating might be bled from the turbine, the exhaust from the auxiliaries is available, and furthermore, there is a minimum economical limit to the quantity of steam that can be bled at low pressure.

The curve shown in Fig. 5 is plotted for a standard make of bleeder turbine having a capacity of 300 kw. at full load, and gives the quantity of steam required at the throttle when different amounts are bled. The conditions of operation for these relations are initial pressure, 175 lb. gage, extraction or bleeder pressure, 2 lb. gage, steam dry saturated, vacuum 28 in.

Assuming the return-line vacuum system of heating to be employed, the same steam requirement per hour is needed during the different months as in Case 4. By using the quantities given below as the pounds of steam bled per hour, the corresponding weight of steam required at the throttle is found from the curve in Fig. 5. This, multiplied by 188, the working hours per month, gives the total pounds of steam for both power and heating purposes, as shown in the last column.

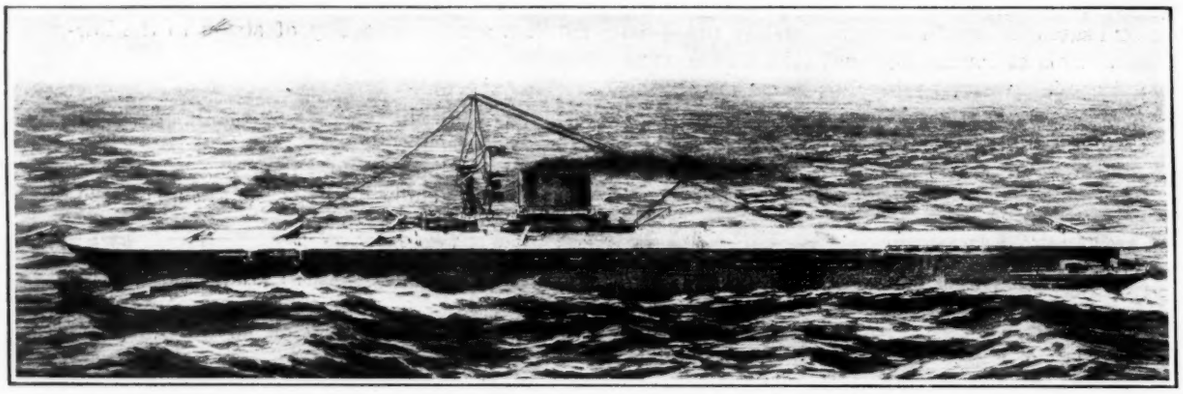
Month	Average Outside Temperature, Deg.	Pounds of Steam Bled per Hour for Heating the Buildings	Pounds of Steam Required per Hour at the Throttle	Pounds of Steam Required at the Throttle for the Month
September	60	3,200	8,350	1,569,800
October	50	4,000	8,800	1,654,400
November	40	4,800	9,200	1,729,600
December	30	5,600	9,600	1,804,800
January	20	6,400	10,000	1,880,000
February	30	5,600	9,600	1,804,800
March	40	4,800	9,200	1,729,600
April	50	4,000	8,800	1,654,400
May	60	3,200	8,300	1,569,800
June	70+	.....	6,600	1,240,800
July	70+	.....	6,600	1,240,800
August	70+	.....	6,600	1,240,800
Total for year				19,119,600

The total for the year should be increased 2.5 per cent to cover the steam used by the condenser pumps, which brings it up to 19,597,600 pounds.

Comparing the results obtained in Case 6, using a bleeder turbine, with the other three methods, gives the following.

Compared with Case 1, 389 tons of coal are saved annually, or 27.4 per cent. With Case 2, 328 tons, or 24.1 per cent. With Case 3, 142 tons, or 13.7 per cent.

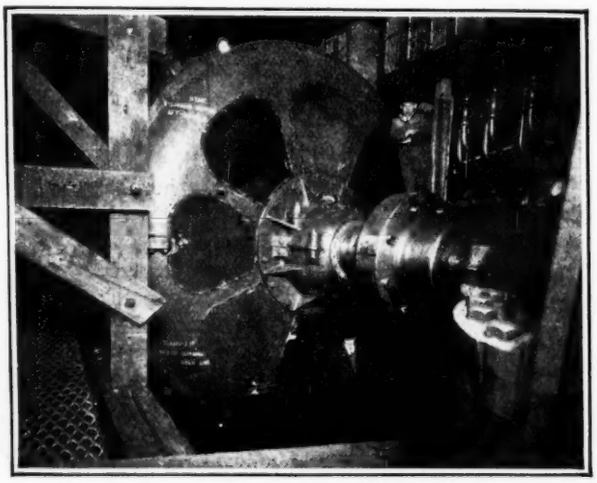
As previously stated, while these results apply closely to the assumed conditions, the problems have been worked out especially for illustrating the methods, which may be applied, with suitable modifications to any similar case.



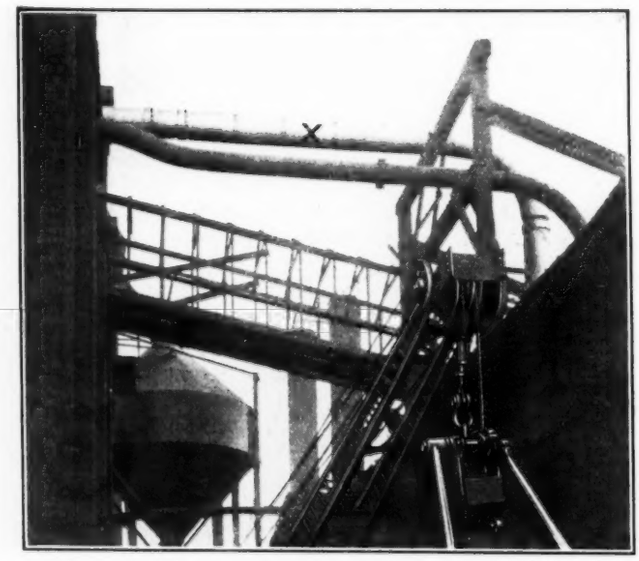
Artist's sketch of airplane carrier, typified by U. S. S. "Saratoga" which was launched April 7 at Camden, New Jersey

This 35,000-ton ship, the largest yet launched in America, will have an over-all length of 874 ft., a beam of 105 ft. and a maximum speed of 40 miles per hour.

Right—One of the 22,500-hp. propelling motors of the Saratoga. Two such motors, in tandem, are attached to each of the four propellers, giving a total of 180,000 hp. Current will be furnished by four 35,200 kw. turbo-generators operated by steam from sixteen oil-fired boilers

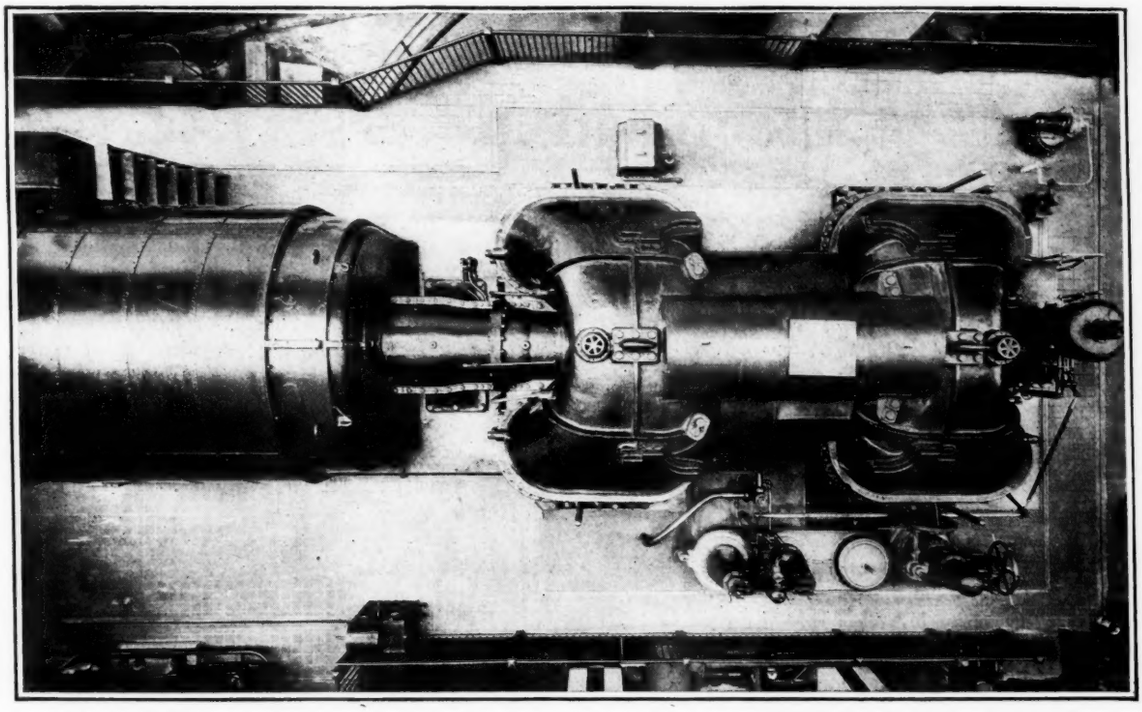


Photos furnished by Gen. Elec. Co.

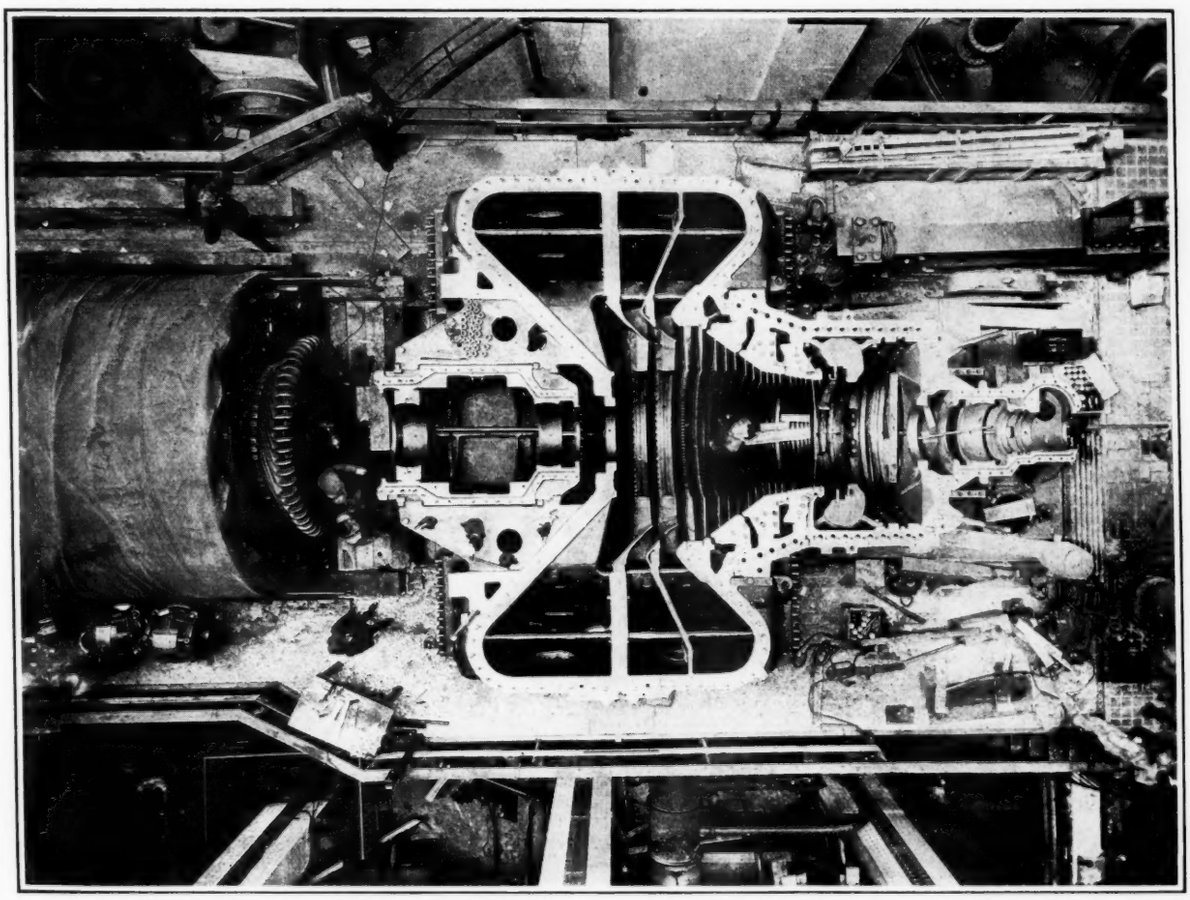


Pipe marked "X" was insulated without scaffolds or ladders

The pipe shown was a 10-in. steam main running from the boiler house to the steam-hammer shop of a steel mill in western Pennsylvania. Two mechanics were executing a contract involving the covering of nearly one thousand feet of steam piping with 85-per cent magnesia. The cost of scaffolding to cover pipe *X*, about 40 ft. above the ground and perhaps 15 ft. diagonally above the runway, would have made a serious dent in the profits. The difficulty was solved by loading the mechanics, with all necessary materials and tools for the complete job, into the bucket of a locomotive crane that ran on a track between the buildings. Less than a day was required to apply two layers of sectional insulation, and finish off with a weatherproof covering.



This 35,000-kw. turbo-generator has been in service for a year at Cahokia. The double-flow design was adopted to permit the use of shorter blading in the low-pressure stages



The 40,000-kw. unit now being installed attains short blade length without double-flow construction by the use of the new Baumann blading in the three lowest stages

Photos on this page used by courtesy of "Wire and Pipe"

Selection, Use and Care of Recording Electrical Meters*

By J. ELMER HOUSLEY
Electrical Engineer, Aluminum Company of America, Alcoa, Tennessee

DESERVEDLY important is the selection and use of recording electrical meters in the power plant and manufacturing establishment. The reason is evident from the fact that the record of such a meter presents a graphic picture for a complete operating cycle, which may be 24 hours or 7 days, depending on the detail desired or the nature of the process under observation or test. The recording meter may be called the watchdog of the plant, and it not only "sounds" the alarm to the operator in case of improper manipulation of a machine, but also leaves a written message that must be explained in case an operator may have been at fault. For a comparison of performance of machines or process in the hands of each succeeding plant shift during the day the record chart is indispensable. Where batch mixing is under the control of an operator or a cycle of two or three days is necessary to prepare material in process, the recording meter gives valuable data concerning the proper processing, power consumption, peak demand and power outages, over which many disputes occur unless there is a permanent record.

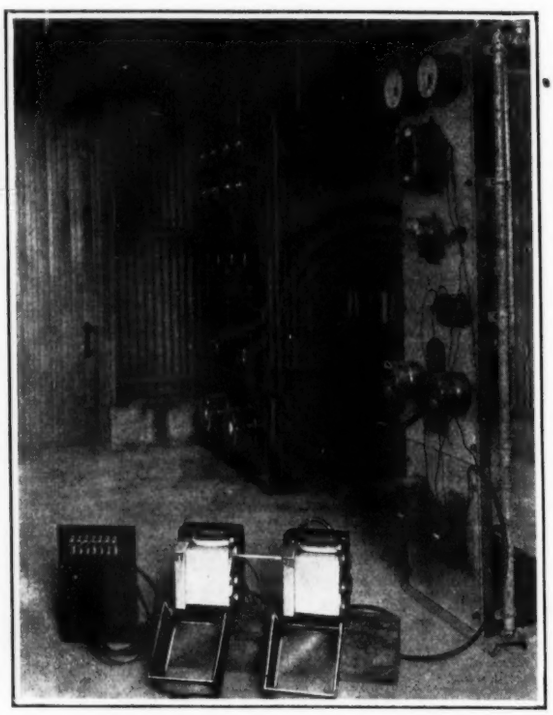


Fig. 1—Recording wattmeter and power-factor meter connected with meters on switchboard for checking industrial power load

Various types of recording meters are made by the large electric companies, and a few companies specialize in producing recording meters. The selection of a meter may be made from an almost infinite variety, and thereby the choice becomes increasingly difficult to make. As a means of analysis of various types we may consider such points as type, reading accuracy, permanence of calibration, cost, life, maintenance; considering the type of meter we must designate, whether the load or use demands an ammeter, wattmeter, voltmeter, power-factor meter or what general class of meter is desired for furnishing the information.

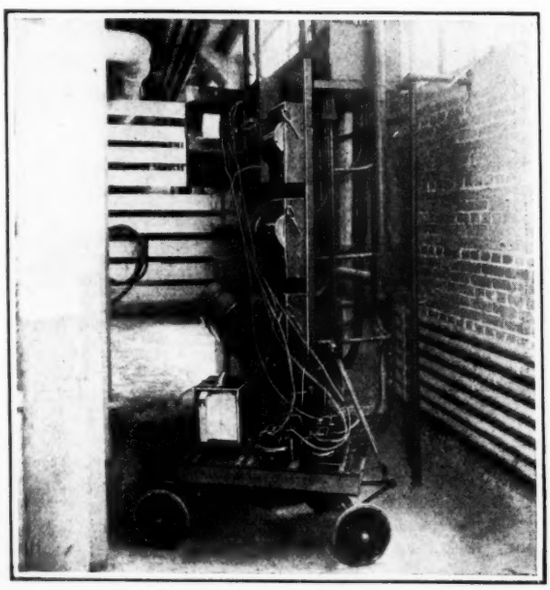


Fig. 2—Recording meter mounted on small truck for convenient use

Reading Accuracy of Meters

Having determined the type of meter, we may investigate the reading accuracy of the different kinds. The length of scale is important, and the speed of chart where the readings swing at close intervals must be such that too much overlapping does not occur. For many loads a circular chart will give all the space required, but a strip chart is sometimes desirable for fluctuating loads so that a higher chart speed may be obtained. The friction of the pen on the paper may be sufficient to give a 5 per cent error in some low-torque recorders, and if close accuracy is required this information must be obtained for each instrument under consideration.

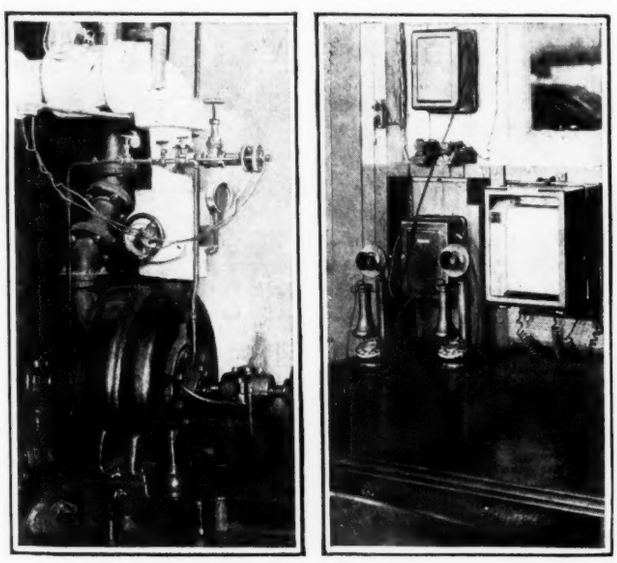
Permanence of calibration is of great importance in some cases, but in others it is not a factor. Where loads are determined for accurate power analysis or for department charges or estimates of cost, permanence of calibration is worth spending money to obtain. In other cases where the loads are compared from day to day to determine changes without reference to charts of a month or a year ago, some of the cheaper instru-

*Photographs by courtesy of the Esterline-Angus Co.

ments which do not have great permanency of calibration or a good reading accuracy may be just as satisfactory as the highest grade of meter. For some work it must be remembered that a reading 10 per cent in error may be considered accurate, while in another case a 2 per cent error is undesirable. It is seldom that a recording meter can be read or calibrated closer than 1 per cent or 2 per cent of the reading of good indicating test meters.

The qualities that are desired in an instrument have been considered, and we may now compare the costs of instruments having the qualities necessary for our purposes. A low-cost instrument usually carries with it the following qualities: Circular chart, low torque, high pen friction, low reading accuracy and no great permanence of calibration. As each of these qualities is improved, the price increases and usually, as a bonus, we secure longer life and reduced maintenance and repair charges. The range of price of instruments may be as much as 1 to 10 at times, therefore it is vitally necessary to weigh carefully the advantages of incorporating qualities which are expensive but at the same time are not indicated by the needs of the job.

A voltmeter is the first recording meter one is most likely to buy, and this of the portable variety. It is possible to keep such a meter continuously employed with no more effort than to change a chart once a day, wind the clock and ink the pen. One of the important uses of this meter is to check the voltage at the end of feeders and compare the chart with switchboard log sheet or substation voltmeters. The regulation of such feeders is important with respect to line loss, overheating of motors where voltage drops 10 per cent or more below normal and reduction in speed.



Figs. 3 and 4—Leakage meter on condenser connected to recorder in chief-engineer's office

Another important test with a portable recording voltmeter is to check variation in voltage between phases or unbalance of voltage of polyphase alternating-current systems. The voltage on each phase may be recorded by putting the meter on one phase each week, or if shorter records are desired, the time may be reduced to a day. If the voltage at the power source is constant, this method will give a good average value of unbalancing and by noting the time relation of maximum unbalancing, the single-phase load causing the unbalance can be located and can in many cases be distributed more evenly.

One danger of unbalance voltage on an alternating-current circuit is that 10 to 15 per cent unbalance between phases may cause double the normal amount of current to flow in one phase of induction motors of low impedance. Where direct current is used, low voltage on shunt motors causes a loss in speed with a corresponding loss in production. With series motors it may cause overheating and roasting of the armatures.

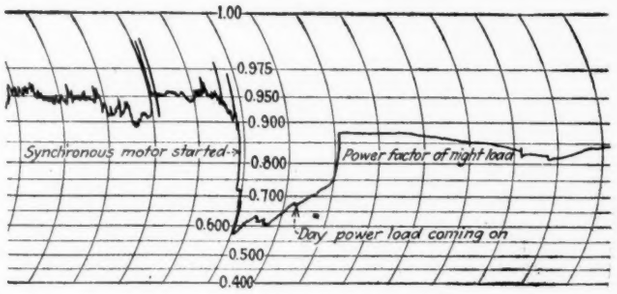


Fig. 5—Recording-meter chart showing power factor of industrial-power load

For lighting circuits the use of a recording voltmeter may pay large dividends in securing proper illumination. The Mazda lamp has the characteristic of lowering its illumination as the square of the voltage at the lamp. Where overvoltage is applied, the life of the lamp is decreased very rapidly. Frequent 24-hour tests should be made on the voltage of all lighting circuits and an effort made to secure an average voltage corresponding to the rated voltage of the lamps used and prevent any great fluctuations in voltage. To fulfill this requirement it is sometimes necessary to run special feeder circuits for lighting transformers, such circuits being equipped with an automatic induction regulator.

Recording Voltmeter in Power House

A high-grade recording voltmeter of the strip-chart type should be installed in the power house or at the incoming substation for every plant in order to check disturbances on the system, to give a record of length of time of interruption to service and to make sure that the voltage regulation is within the limits of the plant's requirements. In one case a synchronous condenser was connected to the main bus of a large plant in order to prevent swings of voltage. By giving a constant high power factor the regulation of the generators was improved.

The recording ammeter is a valuable instrument for use on direct-current drives, and its record is proportional to the load. The alternating-current ammeter record does not give very much information with respect to the actual power load, because of the variation of the power factor of motors, and in small motors the amperes do not increase greatly between one-quarter and full load. However, as a means of limiting the heating of a motor such an alternating-current ammeter may be used to indicate the maximum permissible ampere load on the motor. Such an ammeter may be connected to motors driving centrifugal pumps where the pump characteristics allow the motor to become overloaded and the operator may regulate the discharge

valve to keep the current at or below the allowable limit.

Both alternating-current and direct-current recording ammeters may be applied to machinery drives that are subject to periodic overloads or peaks which may result in damage to motors or mechanical equipment if the operator does not stay on the job. This equipment in general includes all stirring, mixing, kneading or rolling machines where the density or viscosity of process

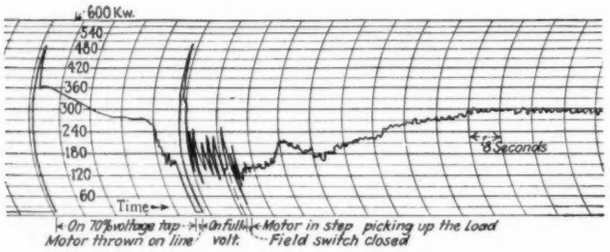


Fig. 6—Recording-meter chart during starting of synchronous motor on ammonia compressor

material may vary. In many instances a switchboard-type recording ammeter may be installed at each drive both for the information of the operator and for those responsible for the operation of the plant and its maintenance.

Recording Meter Prevented Overloading Motors

One instance in mind is that of a large mixing tank in which the rakes would become covered with a dense layer of material and be twisted off. After the second occurrence the reason was believed to have been that the operator went to sleep, as the damage occurred each time a few hours after midnight. After a recording ammeter was installed and the operator was instructed to shut down the drive in case the load increased rapidly, no further trouble was experienced and a somewhat greater output was handled by each shift. The recording ammeter is also used in connection with steam and other flow meters where the steam flow is translated into a current that is proportional to the flow.

The recording wattmeter occupies an important place in general motor and feeder circuit testing. The switchboard type may be applied to generator and feeder circuits and important substations. This meter gives a graphic picture of load conditions, peak loads and line disturbances. A frequent check on feeder circuits should be made to determine if any increase in loading has occurred and to determine the economic load for each circuit. In general this point is neglected in many industrial plants.

Frequency meters of the recording type are usually installed on the main switchboard and are used to determine satisfactory governor performance both as to constancy of frequency and variations due to sudden changes in load. With such a meter changes may be made to governors to give proper stability and sensitiveness as may be dictated by the nature of the load. The meters are relatively expensive and their value must be determined by requirements of the plant. Recording tachometers are sometimes used in place of the frequency meter.

The power-factor meter of the portable recording type is of great assistance in making power-factor surveys of large motor drives, feeder and generator circuits. This meter may be introduced into any polyphase watt-hour meter circuit, and the circuits which require power-factor correction are readily located. The switchboard type is often used on incoming or outgoing feeders of power substations for use in determining the power-factor of the load, and this information is of value in checking the voltage regulation of the circuit.

A recording meter of considerable interest to the power plant is the electric temperature recorder or thermocouple operating a recording millivoltmeter. Although the millivoltmeter is a delicate and expensive instrument, its accuracy and wide range have made a place for it in many power houses and industrial furnace rooms. Owing to the low torque of the millivoltmeter a pen cannot well be attached directly to the instrument pointer, and in consequence some "spark" or mechanical means must be provided to mark the chart with the position of the pointer at frequent intervals in order to make a dotted line, leaving the pointer free to move between each marking operation. Another use to which the millivoltmeter is well adapted is for making a 24-hour ampere chart of direct-current circuits of large capacity. The recorder is connected across the usual 50- or 100-millivolt shunt of an indicating ammeter, and a constant for the recorder chart is readily determined by checking against the indicating meter. Such a meter has frequently been used for securing graphic data regarding peak and average loads for direct-current crane and mine-locomotive service. In each case it is necessary to determine the maximum millivolt capacity of the instrument and of the shunt in order to prevent burning out a meter by applying an over potential.

Recording Conductivity Meters

Another meter that is available to the power plant is the recording conductivity meter for recording condenser leakage and concentration of salts in boilers; for the latter purpose it is only necessary to measure a sample of water at intermittent times. As its name implies, the meter measures the conductivity of water between two electrodes that are in circuit with the meter and a source of potential, the conductivity of distilled water being zero and increasing with the amount of soluble material in the water.

The same methods of connecting and handling recording meters are followed as for indicating instruments. Owing to the presence of ink a little more care must be given to cleaning the meter and removing spilled ink. The clocks should be cleaned and oiled once a year by someone competent to do this class of work. Where oil or glycerin is used for damping, these chambers should be cleaned of dust and dirt and new fluid put in as often as the condition of the instrument would indicate. Every recording meter should be compared with a good indicating meter at frequent intervals and a calibration curve made and used where the accuracy of the instrument is such that this is desirable. The details of suspension of elements, insulation, damping, inking systems, chart speed and range of scales may be compared by studying the catalogs of the various makers.

When there is a film of oil on the cylinder of an engine, if it is of the right thickness and the oil possesses the proper characteristics, the friction of the tight-fitting ring can be lessened and the seal of the loose-fitting ring improved.

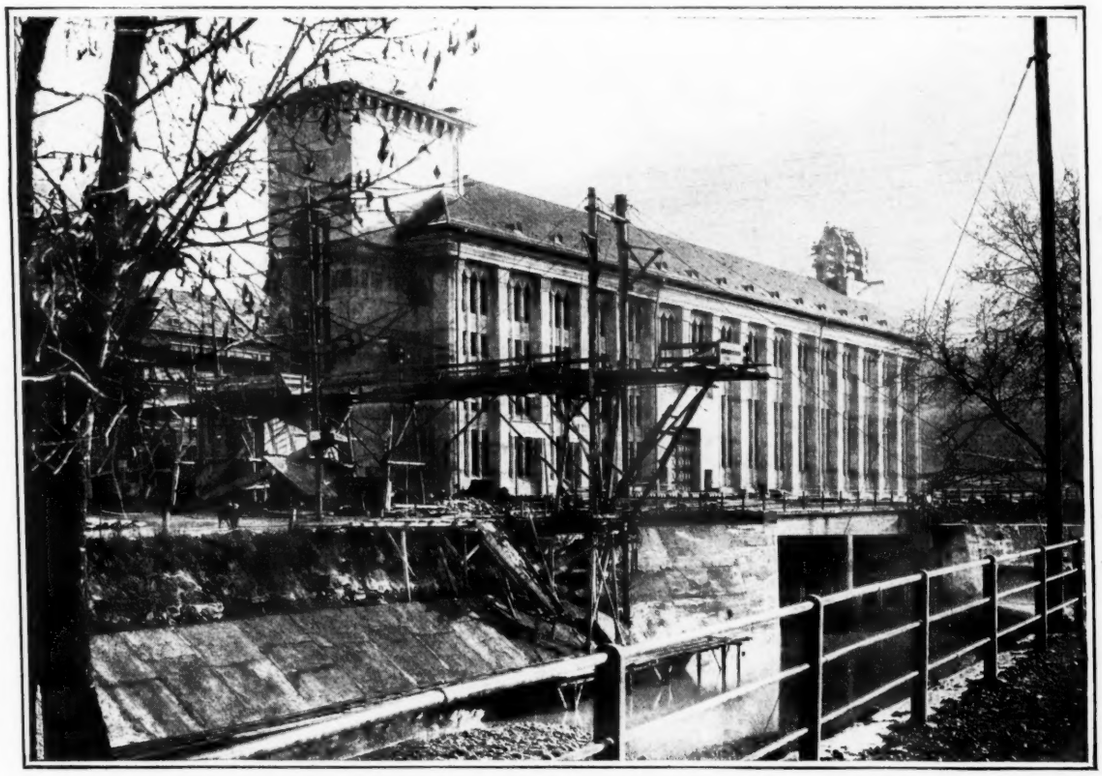


Fig. 1—Power house and tailrace at Seibnen, one of two plants in the project

Water Pumped in Summer to Develop Power in Winter*

Hydro-Electric Power Development in Switzerland Will Have a Rated Capacity of 140,000 Hp.—Water During the Summer Is Pumped into a Storage Reservoir, by Four 5,000-Hp. Pumps and Used for Generating Power in Winter

THE hydro-electric works in the Wäggital, which is under construction by the A. G. Kraftwerk Wäggital, will be the largest power development in Switzerland when completed. It is designed for a maximum output of 140,000 hp. and will be used during the winter only, the water being stored during the summer to insure a sufficient supply for five months in winter. This project is a two-stage development, Fig. 6, with two power houses about 2.5 miles apart, one at Rempen and another at Seibnen. The water is obtained from a reservoir formed by damming up the valley near the head of the Aa River.

The difference between the highest level of the water in the Wäggital reservoir and the tailrace at Siebnen is 1,494 ft., giving an effective head of about 1,427 ft. after deducting losses in the tunnels and penstocks.

As the economy of the development increases with the height of the water in the Wäggital reservoir, this level has been made as high as possible. The maximum level to which the water may be permitted to rise has been fixed at 2,953 ft. above sea level. The Wäggital reservoir is about 2.8 miles long and has a surface area at the highest water level of 1.6 square miles. The lowest level to which it is practical to draw the reservoir is 2,805 ft. above sea level, which is 38 ft. above the bottom of the reservoir. Unless the water level is reduced below this, it is impossible for air to be drawn into the tunnel. The amount of water available is 5 billion cubic feet. When the water has fallen to the low level previously mentioned, there still remains about 300 million cubic feet which can be drawn upon to a certain extent in case of emergency.

The geological conditions in this location are favorable for the erection of the dam at Schräh, Fig. 4. The top of the dam is 7 ft. above the highest water level in the reservoir and is about 213 ft. above ground level, with the foundations going down to about 105 ft. below this level. At its base the foundation is 250 ft. thick, and this dimension decreases constantly to a minimum of 13 ft. at the top. In order to allow inspecting the dam, five galleries have been arranged at various heights on the water side and are connected by vertical shafts.

The water is taken from the reservoir through a

*The information in this article was supplied by S. Kilchenmann, Chief Engineer, Sulzer Bros., Ltd., Winterthur, Switzerland.

Fig. 2—Left. Seibnen power station and switch house

The power house is shown on the left and contains four vertical Francis type turbines rated at 16,000 hp. under a net head of 582 ft. These units operate at 500 r.p.m. which gives them a specific speed of 22 in the foot-pound system.

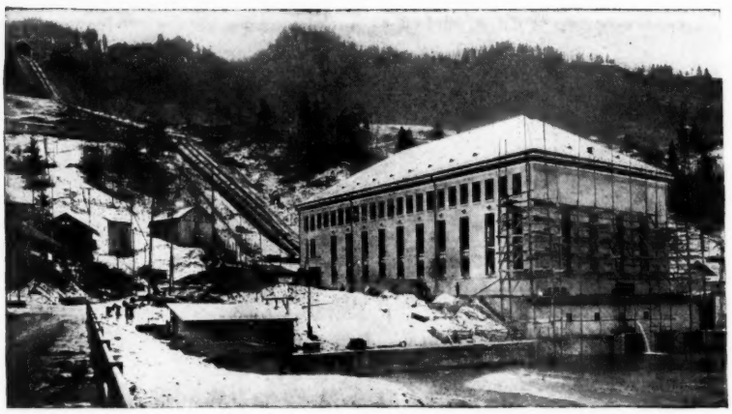


Fig. 3—Right. Rempen power house and penstocks

This plant contains four 16,500- to 20,000-hp. vertical Francis turbines operating under an effective head of 656 to 817 ft. at a speed of 500 r.p.m. These turbines are connected to 14,000 kw., 8,000-volt 50-cycle generators. This plant also contains four centrifugal pumps driven by 5,000-hp. motors.

Fig. 4—Left. Schräh dam, which forms the Wäggital reservoir

This dam is vertical on the reservoir side and is 362 ft. high, 216 ft. of which is above ground. The base is 246 ft. thick and this dimension decreases to a minimum of 13 ft. at the top which carries a roadway. With a draw down of 148 ft. a storage for five billion cu.ft. of water is provided in the reservoir.

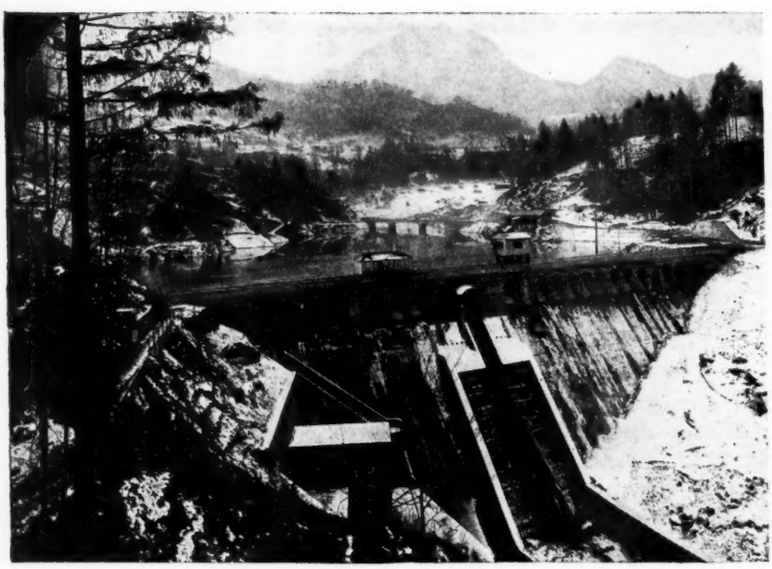


Fig. 5—Right. Dam and reservoir below Rempen power house

Water is pumped from this reservoir into the Wäggital during the summer months by four 20,000 gal. per min. centrifugal pumps located in the power house and is stored for power purposes in winter. The penstocks and tunnel which connect the Rempen power house with the Wäggital reservoir are used as the discharge line for the pumps.

circular tunnel 11 ft. 10 in. in diameter with a total length of about 12,000 ft., which, although driven in solid rock, is concrete lined for its entire length in order to keep the head loss to a minimum. A surge tank has been constructed where the tunnel joins the two penstocks above the power house at Rempen. The penstocks are equipped at their upper ends with valves that can be actuated electrically from the power house and are so arranged that they close automatically in case of a failure in the penstocks. The penstocks are 8 ft. in diameter at the top and 7 ft. at the lower end, and their total length is 1,935 ft., of which about 492 ft. is riveted and the rest welded. The penstocks are laid in the oper and are supported at every 50 to 75 ft. on iron rollers (see Fig. 3).

Of the total 140,000 hp. capacity in the development, 76,000 hp. will be installed in the Rempen power station. This plant contains four turbines, each of 19,000 hp. rating, connected to 14,000-kw. 8,000-volt alternators, the current from which is stepped up to 45,000 volts at the station.

In addition to the generating units there are four pumping units in the power house, each consisting of a high-lift centrifugal pump driven by a 5,000-hp. electric motor. This pumping plant is the largest in the world for the storage of hydraulic energy. The pumps will work principally in the summer months and use surplus electric energy generated elsewhere to pump water into the Wäggital reservoir, thus increasing the supply available for use in winter. The water from the basin of the Aa between the dam at Wäggital reservoir and Rempen, and also the water of the Trebsenbach River, collects in summer in the lake at Rempen and will be pumped into the Wäggital reservoir, the penstocks and tunnel serving as a delivery pipe. The pumps are of the three-stage high-lift centrifugal type, each capable of delivering 20,000 gal. per min. against a head of 805 ft. when running at 750 r.p.m. The turbines as well as the generators are of vertical design, as this allows a more favorable flow through the turbines and more efficient utilization of the draft head.

The lake at Rempen assists in adjusting the flow of water when the power station at Rempen and Seibnen do not require the same amount. At the same time the lake serves to store water during the day in summer so that it can be pumped up during the night by means of surplus electric energy, into the Wäggital reservoir. The local conditions at Rempen allowed of a dam, Fig. 6, about 100 ft. high being erected across the valley, immediately above the mouth of the Trebsenbach River. By this means a lake has been formed from which 13,000,000 cu.ft. can be drawn by lowering the surface level 33 ft. An open canal 840 ft. long, turns the Trebsenbach River into the lake (see Fig. 6). The water from this stream is admitted to the canal over a small weir, which serves for clearing the water and holding back gravel and sand.

The entrance to the tunnel conducting the water from Lake Rempen is 2,050 ft. above sea level. The cross-section of this tunnel is the same as that of the one from Wäggital reservoir. Also the penstocks to the lower power station are in general arranged the same as those to the upper station. They are two in number, 8 ft. 2 in. in diameter at the top and 7 ft. 2 in. at the power house, constructed of plates ⅜ in. to 1 in. thick. The penstocks are 2,675 ft. long and are laid underground and embedded in concrete. The power house at Seibnen contains 4 turbines of 16,000 hp. each, which drive alternators rated at 11,300 kw. and 8,000 volts.

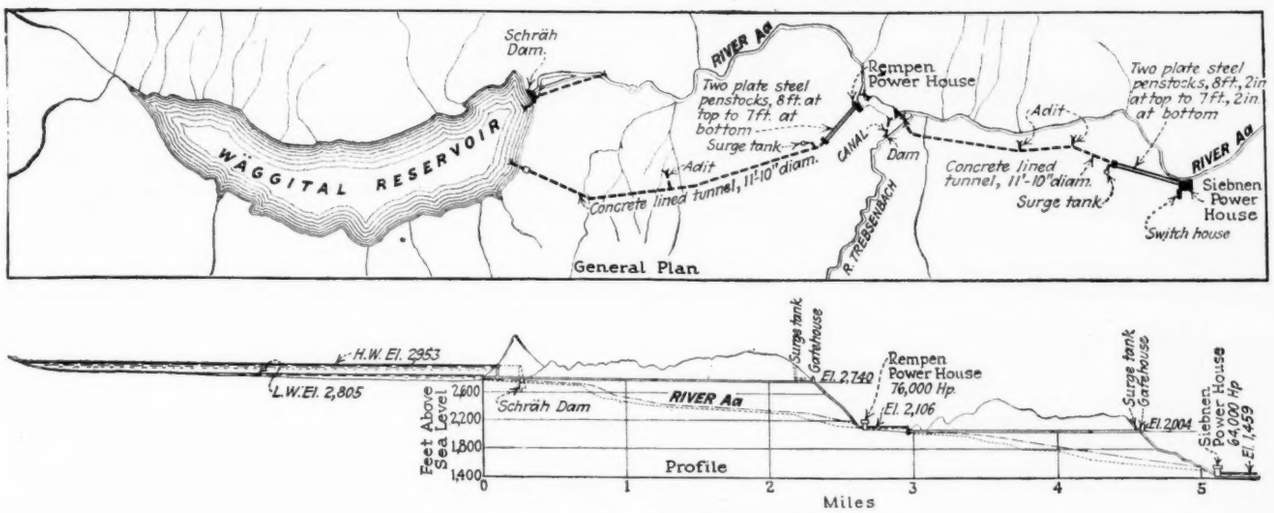


Fig. 6—Plan and profile of Wäggital development

Both power houses are connected with the transmission lines running from the Albula power station to the City of Zurich. They can also work in connection with the transmission lines of the North East Swiss Power Works. The Wäggital Works are thus connected with the mains of this company as well as those of the Zurich Municipal Works. Another line allows the Wäggital Works to be connected to the Swiss "Sammelschiene," a line which runs from Toss to Kallnach and to which all the larger Swiss Power Works are connected.

It appears quite proper that the efficiency of domestic heating boilers at maximum ratings should be quite low, provided the maximum efficiency part of the curve is present at a low rating. Average experience indicates that the maximum capacity will be called upon only about 18 per cent of the entire heating season, so that a better inherent efficiency at lighter loads during the 82 per cent remainder would be of greater advantage.

Notes on Oil-Engine Lubrication

BY R. G. MELROSE

MUCH has been written on Diesel lubrication problems recently, but the fact remains that this field is to a great extent unexplored.

For instance, some years ago I experienced trouble due to excessive wear of air-compressor cylinders and piston rings. The oil used was a good grade of mineral of the following specifications:

Specific gravity at 60 deg. F.	0.88
Flash point open cup, deg. F.	420
Viscosity at 70 deg. F.	604 Redwood Secs.
Viscosity at 140 deg. F.	100 Redwood Secs.

This grade was subsequently changed for an oil of lower flash point, much against the advice of several engineers who had had extensive experience with lubricants; nevertheless the results were very gratifying, as the wear was entirely eliminated. The specification did not differ appreciably from the first sample as an examination of the two investigations will testify. The second example was as follows:

Specific gravity at 60 deg.	0.891
Flash point open cup, deg. F.	405
Viscosity at 70 deg. F.	749 Secs. Redwood
Viscosity at 140 deg. F.	105 Secs. Redwood

Any intelligent engineer will deduce from the foregoing that it is practically impossible for him to give a verdict on the propensities of an oil offhand, and furthermore, he invariably is not in possession of instruments to make his own analysis.

I read an article in a contemporary publication some time back about an engineer who gave instructions to his fellow engineers on oil testing. One test was sense of smell. Now it is possible that an engineer can detect the difference between animal oils, vegetable oils and mineral oils, but no reputable oil company is going to palm off an animal oil on him for a mineral oil, and as for differentiating between one mineral lubricating oil and another by means of the olfactory organ, it simply cannot be done. Another test consisted of taking a drop and rubbing it between the forefinger and thumb. This was apparently a viscosity test. The absurdity of this procedure will be obvious to anyone who is aware of the difficulty of getting accurate figures even with a viscometer.

It will be observed that the engineer is practically at the mercy of the oil company, but at the same time, in order to dispel any qualms he may have on the subject, it should be added that reputable oil companies maintain a chemical staff and fully equipped laboratory.

The correct amount of oil for an oil engine is a question that comes up periodically. There is no definite answer that will apply to all types of engines. Take for an example, a crankcase-scavenging engine and one of crosshead construction, both working on the two-stroke cycle and both of the same rating—the lubricating oil consumption for the crankcase scavenging engine is approximately four times that of the crosshead engine.

It may be mentioned at this point that an excess of lubricating oil in a crankcase-scavenging engine will probably find its way into the combustion space with the result that a tendency exists for the engine to run away. This is, however, an exceptional occurrence.

An oil that gives every satisfaction when used for cylinder lubrication may not satisfy all requirements when applied to the air compressor. For instance, a pure mineral oil will probably suit requirements in the engine cylinder, but it may be necessary to utilize a compound of mineral and vegetable oils for the air compressors, a conclusion that has been arrived at only within recent years and that has, to a great extent, eliminated air-compressor troubles.

Where ratchet lubricators are employed, the mechanism should be kept under strict surveillance. A condition came under my notice where several cylinders were overheated and necessitated the renewal of the liners before the engine could be operated again. It appears that the ratchet simply slipped over the cogs without turning the wheel, with the result that the oil supply completely stopped. It is suggested that a white line be painted on the wheels of ratchet-operated lubricators so the attendant can more easily observe if the lubricator is in operation.

The modern practice of fitting a diaphragm plate in crosshead engines for the purpose of isolating the cylinder from the crankcase is to be commended, as it is surprising the amount of sludge and objectionable deposits that are intercepted by the diaphragm which would otherwise find their way to the crankcase and ultimately to the oil sump. A deduction of lubrication conditions can be arrived at by an examination of the deposit on the diaphragm plate, as a liquid mass will denote surplus oil and the presence of small particles of what appears to be coke will indicate an insufficiency of oil.

Quick-Steam Boiler Displayed at Leipzig

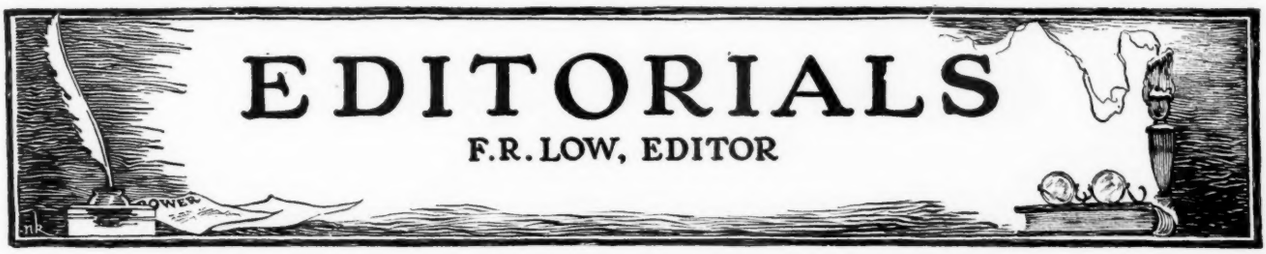
According to *Commerce Reports* the novel Becker high-pressure, quick-steam boiler was displayed for the first time at the Leipzig (Germany) Spring Machinery Fair.

"The small model shown was used to drive a 15-hp. steam engine. It got up 120 lb. pressure and furnished sufficient steam to operate the engine in exactly four minutes. This boiler is fired by an automatically regulated crude-oil burner which heats the tubes red-hot before the atomized water is injected. The flow of both oil and water is automatically regulated by a governor.

"The apparatus was the center of much interest, and it is said that a number of installations were sold for domestic use. The principal advantages claimed are speed of getting up steam, cheapness of first cost (about 40 per cent of standard boiler), freedom from damage due to explosion and economy of fuel. The safety feature is due to the absence of water in the boiler, and its economy is caused by the automatic regulation of the fuel consumed in proportion to the amount of steam used.

"The future of this new boiler is of course problematic. The life of the tubes is questionable and the difficulties resulting from boiler scale will be determined by time."

Oftentimes leaks occur in water or steam lines which can be quickly and conveniently repaired by electric arc welding. Welded pipe lines can be installed, especially for large sizes, more cheaply and easily than any other type of jointed pipe. In one case 400 ft. of 6-in. steel pipe for a water line carrying 400 lb. pressure was successfully installed in a steel plant. The pipe lengths were 20 ft. and the thickness of wall was $\frac{3}{8}$ in. Each joint was beveled at 45 deg. and welded with the electric arc. The cost per joint was approximately $1.55.



Co-operation Between the A.S.M.E. and the N.A.S.E.

WE NOTE with pleasure the announcement of a joint meeting of the Indianapolis Section of the American Society of Mechanical Engineers with the local branch of the National Association of Stationary Engineers. A conference for operating engineers, power engineers and executives was held at Purdue University April 20 to 27, concluding with a banquet at which Samuel A. Insull, president of the Commonwealth Edison Co., of Chicago, was the guest of honor. Mr. Insull lectured later on superpower.

This looks like real co-operation, and it is good to see the operating men taking an active part in it. Their association, which is purely educational and non-militant in its purposes and methods, has not taken the part that it could profitably take in such occasions. Perhaps it has not been sufficiently encouraged to do so.

The operator is a large factor in the efficient performance of a power plant, large or small. Upon his understanding of its object, design and operation, and his intelligent handling of it, depends the degree of success attained by an installation. He is interested in and capable of discussing understandingly the larger questions of power-plant engineering and can offer some suggestions from the mechanical viewpoint of the man who must live with the plant and make it go.

Many are members of both societies, and many others are acquiring as operating engineers that experience which fits them for the larger responsibilities, the successful discharge of which is the hall-mark of eligibility to the professional society. There should be more co-operation of this kind.

Ten Years to Penetrate

A STUDY of American engineering history seems to indicate that it requires, on the average, ten years or more for any revolutionary idea already developed to the point of successful practical application to find general acceptance. The mass is hard to start moving, but a small push steadily applied over a long period will eventually result in a substantial velocity. This thought should encourage those who sometimes grow a bit discouraged at the persistence of uneconomic practices in the power field in the face of repeated and irrefutable demonstration of the advantages of doing otherwise.

It was about ten years after the advantages of the unaflow engine were obvious to trained observers that this type of prime mover secured the general acceptance it enjoys today. The period was even greater for the Diesel engine, increased it is true by an unusual commercial situation.

The point where the disadvantages of too much excess air are admitted by every "Tom, Dick and Harry" dealing with power-plant furnaces has just about been reached, although some of the recent converts to the idea still backslide in practice. It has taken years of pounding away at a few fundamental facts of combustion to gain general acceptance of one of the simplest and best waste-preventing ideas ever propounded.

Another idea just as simple and obvious and with as great (and possibly greater) possibilities for saving good money still fails of complete penetration. Reference is made to the generation of byproduct power from process steam. But this idea, which is already an old, old story to every good engineer, is gradually penetrating the non-technical fringe of manufacturing executives who formerly accepted coal bills, along with the weather, as acts of God. In another five or ten years one may reasonably hope to see all industry awake to the significance of this vital factor in manufacturing costs.

The Engineer, the General Public and Water Power

THE general public is imbued with the idea that water power is cheap and reliable. Much political capital is made of our unutilized resources of "white coal" and of the fact that this heritage of the people should be conserved and developed for their benefit and in some way to provide them with power at lower rates than they now pay. It is well known to engineers that most of the sites where water power can be developed cheaply, have already been utilized. Most of the remaining sites in the more highly industrialized sections of the country will prove expensive to develop. The fixed charges on this high first cost will increase the unit cost of the power developed. The tendency in water-power development will therefore be toward higher unit power costs which must meet competition from steadily decreasing power costs from our large steam stations. This is a phase of water-power development not appreciated by the public.

The water supply in many of our rivers is extremely variable. In certain cases the sources of supply freeze up in winter and dry up in summer. Almost every river has one period of low water each year, while many have two such periods. Low water in winter is particularly bad, for electrical loads are then at a high peak. Such plants often have available for six months or so large quantities of so-called "secondary" power when the river is running full. However, the market for this is limited and it must be sold at low rates if no other reserve source of supply is available during the rest of the year. Many power companies whose main source of supply is from hydro-electric plants have been forced within the last few years to construct steam auxiliary plants to tide them over the power shortages of the low-water periods. Construction of such steam plants has been going on apace in as widely separated parts of the country as Pennsylvania and California. It is reported that even the Hydro-Electric

Power Commission of Ontario contemplates the construction of a steam auxiliary station. In this case the station is to handle short peak loads rather than to offset low water.

More extended development of water power inevitably brings with it more auxiliary steam stations, and the overhead charges on this double development tend to offset the cheapness of hydro power. These facts should be broadcast by engineers so that the public may be more truthfully informed on this important subject. To permit people to imagine that water power is always cheap, merely breeds discontent later when lowered rates are not forthcoming. The engineer has a public duty to see that correct information is given to the public on engineering developments.

Direct-Current Motors for Adjustable-Speed Purposes

HAVING no moving electrical contacts, the squirrel-cage induction motor was free from the brush and commutator troubles of its direct-current predecessor. So far as simple, substantial and reliable construction is concerned, the squirrel-cage motor is without a competitor. This type is inherently a constant-speed machine, and if it is to be designed for high efficiency its starting torque is low for a given current. To combine good starting torque with efficiency the wound-rotor induction motor with an external starting resistance came into wide use. If the load is constant on this type of motor, the introduction of external resistance in the rotor circuit also provides a limited amount of speed control, but at reduced efficiency. With such an arrangement the speed varies with the load so that unless the load is constant the speed regulation may be unsatisfactory. Both the squirrel-cage and wound-rotor types of induction motors are inherently low-power-factor machines, particularly at part loads.

To obtain an alternating-current motor that would approach the speed-regulation characteristics of the direct-current shunt motor and also to provide a general-service alternating-current motor with high starting torque and good power-factor characteristics, has led back to the motor with a commutator and brushes. A number of these types not only have a commutator, but also slip rings with brushes. When the motors are designed for speed adjustment, the commutator is literally covered with brushes, a condition never found on a direct-current machine. For adjusting the speed some means must be provided for adjusting the position of the brushes, which may be quite complicated in some systems of control. The power factor of such motors is lagging, and although better than the average induction motor, it is not all that is to be desired, particularly at slow speeds. The speed-torque characteristics of the adjustable-speed alternating-current motor are not as good as the direct-current machines and the speed regulation is also poorer.

This condition raises the question, Why all the prejudice against the direct-current machine? Where a number of adjustable-speed motors are required, a synchronous motor driving a direct-current generator supplying power to adjustable-speed direct-current motors, would, in many cases seem to offer a better solution to the problem than the use of adjustable-speed alternating-current motors. It must be admitted that the motor-generator set introduces a piece of equipment in the system that may cause trouble, but the reliability of such apparatus is high when given reasonable attention, and with a spare set the danger of serious interruptions to service is practically eliminated, as has been proved by experience. Although the combined efficiency of the motor-generator set and the direct-current motors may be lower than that for the alternating-current adjustable-speed motors, when the effects of the power factor of the system as a whole are considered, the efficiency will probably be found to be higher. If power is purchased and there is a power-factor penalty clause in the power contract, the improvement in the power factor by adding a synchronous motor on the system may materially reduce the cost of power. Each class of commutator-type alternating-current motor has an economic place in motor applications, but their use in groups for adjustable-speed is open to question.

Energy Storage

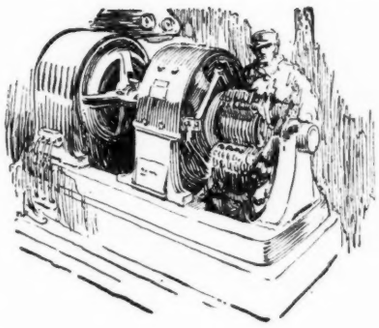
IT SEEMS strange that with the staggering investment for boilers, engines, generators and auxiliary equipment so little effort apparently is being spent in the development of storage mediums whereby the output of a given installation may be increased or some of its apparatus dispensed with.

Fuel, steam, the motion of mechanical parts and electricity, all contain energy, potential or kinetic, that is possible of storage in some form or another. Electrical storage is obviously the most desirable since it could be used to smooth out "production" all the way from the coal pile to the motor or other point of consumption. Steam storage may benefit the boiler plant, but not necessarily the prime mover or transmission equipment. Fuel is the most easily stored, but is placed at the end of the chain where none of the energy converting elements may be served.

Of recent years electric storage has been used commercially to help smooth out the station load as shown by the application of batteries for trucks, etc., which may be charged at night or other preferred periods of light station load. In spite of the fact that the storage battery has had a comparatively long period of development, its efficiency and cost at the present time is not conducive to utilization on a large scale for the benefit of the power plant, nor has it been adapted to alternating current. For large capacity units and short time intervals of energy flow the motor-generator-flywheel combination has of late years found wide application. In steel mills, its function is to change a fluctuating electrical demand into a more uniform curve at the generating station, which, however, would not greatly reduce the average daily load. There are many other means of securing energy storage, though all lack much of meeting present-day requirements.

Judging from the large number of requests coming in for extra copies of the Diesel engine insert which appeared in the April 21 issue, there is a widespread interest in the oil-engine plant. Attention has been called to the apparent complexity of the layout and in this connection the title, "A Typical Diesel Engine Plant," was unfortunate. This complexity was brought about by an attempt to show upon one sheet all the apparatus and appliances that might be used in connection with a Diesel engine and the way that they fit into the system. The average plant does not contain anything like so much auxiliary equipment; no plant would, of course, contain it all.

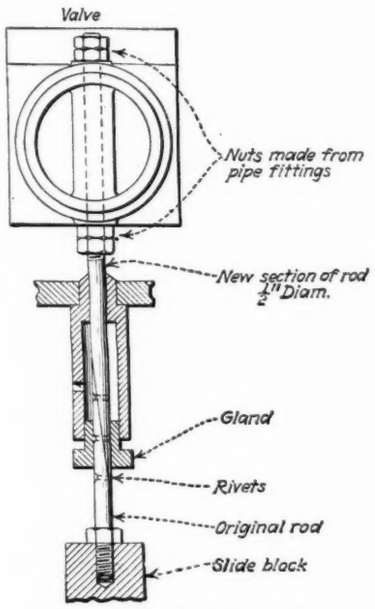
Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for March will be announced next week.

How the Valve Stem Was Repaired in an Emergency

Shortly after the war I was third assistant engineer during a trip to Valparaiso, Chile, on one of the wooden cargo ships built as a war emergency. A few days' sail below the Panama Canal the valve rod broke on the small vertical engine driving the lighting generator. The rod was ½ in. in diameter, and on looking over our supplies we found we had one piece of steel of proper size on board. When we dismounted the valve stem from the engine, however, we found that the upper end of the rod was threaded with thirteen threads to the inch on which was run ordinary nuts and locknuts, while the lower end of the rod which screwed into the guide block had twelve threads to the inch. Our dies were thirteen threads, but when we started to use them we found that, being a war-time product, they were too soft to cut a thread on the rod. After using oil lanterns for a few days, we found that our kerosene store was not going to last until we reached port, so it was necessary that we make an attempt to repair the engine. As our facilities for making repairs and our supply of tools was somewhat limited, we decided on the following method:



Detail of valve rod

We sawed the ends off some brass pipe fittings which had reinforced shoulders and filed sides on them, thus making nuts with pipe threads. We then took the spare piece of steel, which was ½ in. in diameter and ran a ¼-in. pipe thread on one end. The threads were not very deep, but as brass fittings run with a heavy thread we found that our makeshift nuts would hold. We then cut and filed the other end of the rod to a long bevel, and taking the lower end of the original stem, we filed the upper end to a similar long taper. After drilling three holes through both pieces and filing large nails to a proper size to make rivets we riveted the pieces together and assembled the rod on the engine. Although the splice ran through the packing gland, we made port without further trouble. The only tools we had to do this work with were a breast drill, hand hacksaw, file, pipe dies and the usual wrenches found around a ship of this class.

F. L. GILLMOR.

Albany, N. Y.

Use of Treated Water in Cylinder Jackets Prevents Scaling

In a certain combined ice-making and electric-light plant in which oil engines were used as prime movers, considerable difficulty was had from heavy deposits in the cooling jackets of the engines.

During certain seasons of the year when the well water was unusually bad, the scale deposits in the engine cooling jackets became serious and caused no end of trouble.

In order to improve the quality of the raw-water ice, a modern water conditioning plant was installed and it was later found that the water softener had a capacity somewhat in excess of the ice-making requirements of the plant.

It was then decided to use treated water for cooling the engine cylinders, and accordingly a small spray pond was built and equipped with spray nozzles and a circulating pump. Water from the spray pond was discharged directly to a distribution header at the engines, passed through the jackets and on to an elevated storage tank. From this point it flowed by gravity to a second pump which discharged it to the nozzles for cooling.

As the power actually required to handle the water was comparatively small and there was sufficient treated water to make up the windage and evaporation losses, the plan proved to be a most economical one. After a few weeks' operation the engine jackets were free from scale and the engines again operated without apparent difficulty.

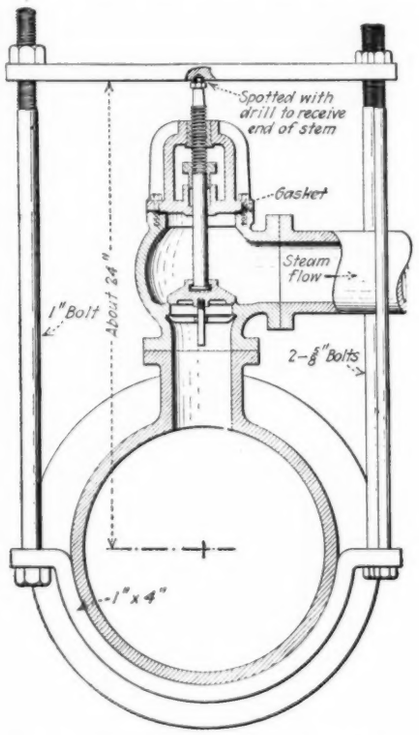
In this plant the water-conditioning apparatus served a double purpose, materially improving the quality of the manufactured ice as well as eliminating cooling-jacket troubles.

C. T. BAKER.

Atlanta, Ga.

Renewing Valve-Bonnet Gasket with the Valve Under Pressure

Recently, in the plant in which I am employed, it became necessary to renew a gasket on the bonnet joint of a 3-in. angle valve. As we could not shut the steam off the header to which the valve was connected, we had to devise some means of holding the valve shut



Method of holding valve shut while renewing bonnet gasket

while the gasket was renewed. The illustration shows how it was accomplished. The work had to be carried out with considerable care and extra precaution taken to prevent any jarring or moving of the clamp while the job was being done.

A clamp was made of two pieces of flat iron, one bar being placed on top of the valve stem and the other bent to a semicircular shape and placed below the header. The top bar was recessed slightly to receive the end of the stem to prevent it from slipping. The two bars were then connected together by bolts, two bolts being used at one end, one on each side of the pipe in order to steady the clamp. When the bolts were drawn up tight to hold the valve to its seat the nuts were removed from the bonnet studs and the stem was turned in the direction for closing the valve. By turning the stem, the bonnet was raised about ½ in., which was sufficient to permit cleaning the surfaces and inserting the new gasket. The gasket was made with a dovetailed joint so it could be slipped around the valve stem. The gasket was then closed by matching the dovetail, and put in place. G. W. HARRISON.

Houston, Texas.

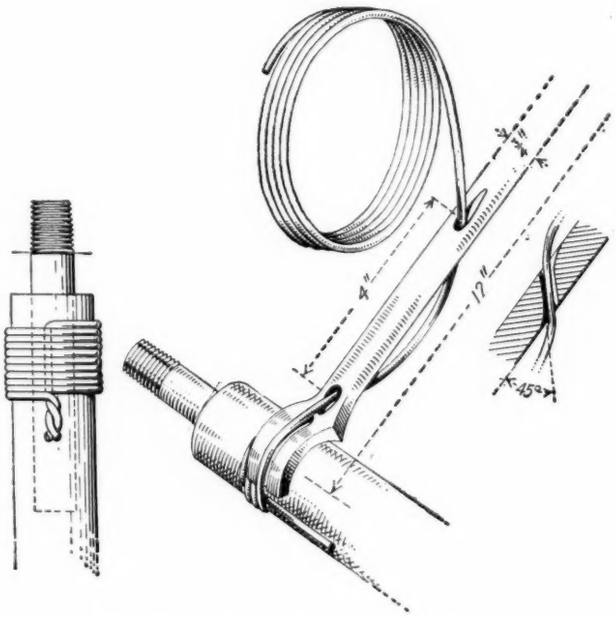
[While a repair of this kind might be done with reasonable safety on small valves under relatively low pressure, it is not recommended on large valves except in extreme emergencies and then only when the greatest care is exercised.—Editor.]

Wire Clamping Tool for Compressed-Air Hose

In the iron mines there are numerous lengths of ½-, ¾- and 1-in., four- and five-ply rubber hose in use to supply compressed air to the rock drills, and consequently a great many connections have to be made in connecting the hose with the supply pipe and the drills. The illustration shows a tool in use in a number of the mines for winding wire around the hose to hold the nipple in place, thereby doing away with the usual clamps and bolts.

The dimensions given are approximate for a tool used in clamping a 1-in. four-ply hose. The clamping is done in the following manner: On one end of a piece of ¾-in. pipe 6 in. long a standard pipe thread is cut, and on the other end a 1½-in. bolt thread about 3 in. long. The end with the bolt thread is inserted in the hose about 4 in., and the hose is ready for the wire clamping.

A No. 14 Stubs gage soft steel wire is used. The wire is cut in 9-ft. lengths for winding a 1-in. hose, shorter lengths being used for smaller hose. The wire is first wound up on a piece of 3-in. pipe with a slot cut in it so that the wire can be hooked in it and held in place while the bundle is being wound. When a hose is to be clamped, a bundle of wire is taken and started on the tool as shown in the illustration. The wire is fed through the tool until about 4 in. extends beyond the



Completed job of wire clamping and tool in position for winding

point of the tool, this is then bent at a right angle, and is laid on the hose lengthwise. The wire is then wound around the hose layer after layer, and when the final turn is made the two ends are given two twists and the job is done. Any number of lengths of hose may be connected in this manner. The two holes through the handle are drilled at an angle of 45 deg., which gives the proper tension to the wire when winding. THOMAS PASCOE.

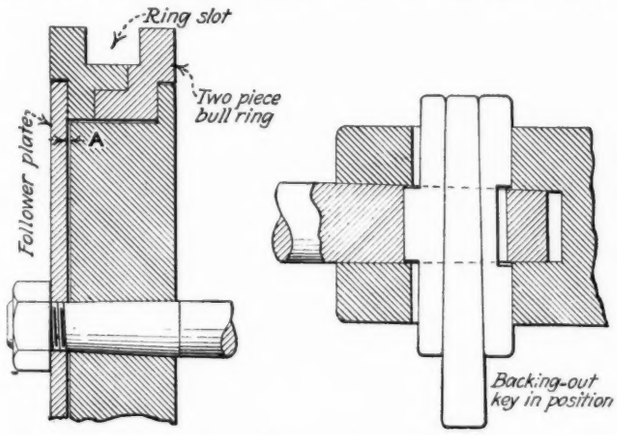
Norway, Mich.

Overhauling a Corliss Engine

To prevent waste of steam, we found it necessary to rebore the cylinder and valve chambers of the shop engine, during the July, 1924, shutdown.

The cylinder was not badly worn, and the steam valves were in fair condition, but the exhaust valves were in bad shape. Arrangements were made with the builder of the engine to furnish castings for the valves, bull ring and packing ring, the finishing to be done in our machine shop; also, he was to furnish boring bars and a man to supervise the work. Incidentally, our principal reason for giving the job to the builder of the engine was that he had the patterns for all the parts, otherwise we should have had to make drawings and patterns, which would have added much to the cost.

Our first work was to dismantle the engine, removing the valve gear, piston and rod. A backing-out key



Details of backing-out key and construction of piston

was made in advance, as shown at the right in the illustration. After removing the key used to hold the rod fast in the crosshead, the backing-out key was inserted in the slot and sledged up solid without starting the rod. To break the rod loose, a blow torch was turned on the hub of the crosshead, and when this was heated up somewhat (possibly 150 deg. F.) the sledge was brought into use again, and about the second blow the rod broke loose.

The boring bar was centered in the stuffing-box end by means of a tapered bushing and at the other end by the usual hub bolted to the end of the cylinder, the rod being centered from the counterbore. When the bar had been set correctly, two cuts were taken through the cylinder, a rough and a finishing cut. The tool had a tendency to chatter on the finishing cut which convinced us that an induction or constant-speed motor was not an ideal drive for a boring bar. With a variable-speed motor on an engine drive we could have slowed down the cutting speed and possibly eliminated the chattering.

Man power was used to drive the valve chamber boring bar, and this work was carried on while the cylinder cuts were being taken. As soon as a valve chamber was finished, the valve, which had been rough-finished oversize, was turned to a diameter 0.002 in. larger than the bore, then filed on the side opposite to the seat until it entered the chamber freely. Judging by the satisfactory way in which these valves wore to a good bearing, this is an excellent way to fit them.

The piston ring, which was of the snap type (a snap ring, according to regular practice, where no springs are used, would be turned $\frac{1}{16}$ to $\frac{3}{32}$ in. oversize), was turned only about half as much oversize as usual. As we used springs and did not trust to the natural spring of the metal, we felt safe in turning it close to cylinder size. As placed in the cylinder, the joint of the ring was in the bottom and held there by a dowel. The bull ring, which was a two-piece affair, was finished about 0.015 in. smaller than the cylinder bore. The builder's mechanic told us to have the bull ring project $\frac{1}{32}$ in. beyond the face of the piston spider as indicated at *A* to get the clamping effect when the follower plate was set up, but this seemed excessive to us, so with his consent, we reduced this to $\frac{1}{64}$ in.

Some engineers make a point of turning the bull ring periodically, relative to the cylinder, but it has always been our practice to mark the ring and replace it in the cylinder in the same position. This will, after a little wear, give a bearing practically half the cylinder diameter. It has also been our practice to remove the rings at least once a year and dress off all ridges that had formed on them. This tends to prevent ridges being worn in the cylinder.

The valves are also removed, and all spots showing high are draw-filed. Corliss valves generally show a tendency to ride hard on the ends; if these are draw-filed occasionally, it allows the part of the valve covering the port to make a better contact with the seat.

While the other repairs were being made, the piston rod was put in the lathe and trued up, and as soon as the finished size was known, an order was placed for metallic packing. As the engine was ready for service before the new packing arrived, the rod was packed with fibrous packing. Upon starting the engine a slight jar was noticed when the piston reached the head end, but it was not considered of any consequence. We expected it to disappear as the parts wore in. In due time the metallic packing came and was installed on the rod. When the engine was started, the thump was much worse and caused a perceptible jar on the cylinder.

To satisfy ourselves that there was a connection between the metal rod packing and the thump, we replaced it with the soft packing for a day, during which time the engine behaved quite nicely. We knew there was nothing wrong with the metallic packing, so it was put back in place, and the search for the trouble was started in earnest. We tried stiffer springs under the piston rings and raised the crosshead end of the rod slightly above the center but these changes made no improvement. As the cylinder was double-ported and it had been noticed that the inner port was covered by the bull ring when the piston was at the extreme end of its stroke on the head end, the bull ring was taken out and chamfered off liberally on the top side, so the steam could enter the cylinder through this port at the beginning of the stroke. This improved matters considerably, but was still far from satisfactory. At our next attempt to find the cause of the trouble, we hit the spot, and removed the thump entirely by lengthening the rod to the steam valve on that end, thereby making the admission slightly later. The difference could hardly be detected on indicator diagrams taken before and after. It was a case of the entering steam bouncing the piston; the fibrous packing had a steadying effect, which was totally absent with the metallic.

Anderson, Ind. J. O. BENEFIEL.

Comments from Readers

Oil-Engine Packing

I read with interest the item on page 260 of the Feb. 17 issue which dealt with the use of packing in oil engines.

I have charge of gas compressors working at 1,800 lb. per sq.in., and I find that the thinnest packing is best for all joints. My theory is that the thinner packing presents a smaller surface, or area, to the gas under pressure, therefore the total pressure on the thin packing will be less than on thick packing and will not force the joint out. A thicker packing with the same "pull" on the bolts may blow, owing to presenting a greater surface and consequently having a higher total pressure acting on it.

P. E. LOBBAN.

Bloomfield, N. J.

Pulverized Coal vs. Stokers at Brunot Island Power Station

With reference to my letter in the Dec. 23, 1924, issue in which I advanced the opinion that a properly designed stoker is more economical than pulverized coal when all computations are taken into consideration, the article by J. G. Coutant in the Jan. 13 issue is of interest. Mr. Coutant refers to results obtained in France (specifically to Rouen) by means of powdered coal, but he does not set forth why this type of fuel is used for two hours only when it could be applied continuously.

The saving of coal is the primary requisite of plant engineers in France (coal being very expensive). Therefore, if there was a marked saving in using powdered fuel, it would be imperative to discard traveling grates or other stokers and install the more economical method of employing fuel. As no such thing has taken place, it seems that I am right in saying that when investigation is thorough the stoker wins.

Moreover, from Mr. Coutant's own words it seems that he confirms plainly my opinion when writing: "A big reduction in first cost of installation and the elimination of some labor are demanded with further economies to be established in maintenance and auxiliary power."

M. RATEL.

New York City.

Producer Gas for Desert Regions

I have enjoyed and appreciated *Power* for many years past, especially since it covers all phases of power-plant equipment. However, I have noticed that for a long time no mention has been made of gas engines as prime movers, more particularly those using producer gas. At one time I understand the Crossley gas engine was extensively promoted in this country but for some reason did not appear to give satisfactory service. Since then we have heard little or nothing of gas engines other than those operating on iron blast-furnace gas. Can you advise me whether there are any reputable manufacturers of reliable gas engines using producer gas?

The subject is of particular interest to Western coal mines, most of which are in arid regions where the supply of condensing water is inadequate to permit operating under the best conditions of economy. While many coal mines still generate their own power by non-condensing steam engines, nevertheless the great majority, in Utah at least, are purchasing hydro-electric power transmitted a considerable distance. The poor load factor of the coal mines, running from 40 to 50 per cent, results in a high cost per kilowatt-hour. On the other hand, there is generally an overproduction of slack at these mines which is difficult to market and which brings a low price at the best. It has been the thought of some that possibly the use of gas engines operating upon producer gas from this slack coal might solve the problem of cheaper power.

If any *Power* reader has information along this line, it would be greatly appreciated if it were passed along to us.

L. D. ANDERSON, Chief Engineer,
U. S. Smelting, Refining & Mining Co.

Salt Lake City, Utah.

What Causes the Black Spots?

I have read with interest the several comments that have appeared recently in *Power* relating to what causes black spots on the commutator, and I should like to relate an experience differing somewhat from those already given. Some time ago I was called in to report on a plant having a 300-kw. generator direct connected to a tandem-compound engine. All the usual remedies, such as turning down the commutator, lowering the mica, spacing the brushes, resetting for sparkless running, etc., were tried, but still the black spots would develop.

I tried operating in a totally dark room and, on examining each holder, was surprised to see a faint spark at each brush just as the engine passed over the centers. The engine had a perceptible thump in the main bearing, and I was able to see the synchronism of the sparking with the thump as the crank passed the centers.

Adjusting the main bearing to a smooth running position brought the machine to a non-sparking condition, but the bearing heated up and it was necessary, after several weeks' trial, to slacken it off to the usual loose running condition.

We tried various adjustments of the valves to secure a smooth passing of the centers, with the main bearing so loose that ordinary oiling and attention would suffice, but without success. So we finally returned to as near an ideal indicator diagram as we could get.

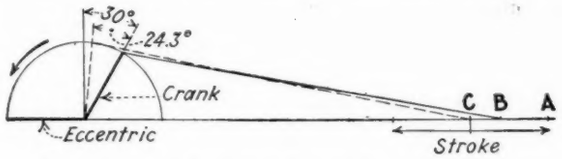
There was a heavy flywheel midway between the main and outboard bearing. The outboard bearing had a movement in step with the thump, but in the opposite direction from that of the crank end of the shaft. I attributed the black spots to the thump.

Columbus, Ohio. SAMUEL P. BAIRD.

Latest Cutoff with Single-Eccentric Corliss Engines

On page 506 of the issue of March 31 L.F.M. is told that a Corliss engine with a single eccentric cannot cut off at half-stroke "unless the eccentric is set less than 90 deg. ahead of the crank with negative lap of the steam valves and tardy action of the exhaust valves."

If the cutoff is assumed to occur at the instant that the eccentric brings the releasing cam into contact with



Showing how cutoff may be delayed

the trip, the answer is correct. If it means the time or the point in the stroke at which the steam is actually cut off, it is misleading, for it takes no account of the time element.

In the sketch herewith the eccentric is shown 120 deg. ahead of the crank or with an "angular advance" of 30 deg. In the position shown it has got to the end of its throw to the left and is starting back. If it has not already tripped the valve, it cannot do so on this stroke. But the crosshead, with a connecting rod 5 cranks long, will have moved only to *B*. In order to move it to *C*, the center of the stroke, the crank and connecting rod will have to move through an angle of 24.3 deg. to the dotted position.

Suppose the engine to make 90 r.p.m., or 1.5 rev. per sec. The crankpin would move through $360 \times 1.5 =$ 540 deg. of arc in a second, or at the rate of $\frac{1}{540}$ of a second per degree of arc. To move through the 24.3 deg. of arc required to bring the crosshead and piston to the center of the stroke, it would require only $\frac{24.3}{540} = 0.045$ sec.

The releasing mechanism, dashpot, etc., would have to be very snappy in order to overcome its inertia and get the valve closed in this space of time. I have seen indicator diagrams from single-eccentric Corliss engines that showed the cutoff as occurring considerably beyond half-stroke. RALPH WHITNEY.

Akron, Ohio.

Valves for Stream Line Flow

Advertisements have recently announced the appearance on the American market of valves designed for stream-line flow. One is inclined to wonder why such valves have not been built before, for there is no inherent difficulty involved in their design. They have been used abroad for many years.

The fundamental idea of such a valve is to design the disk to simulate the action of a venturi meter. The steam will pass through the valve with the least amount of disturbance or eddying and the minimum amount of throttling. Its great advantage is the lessening of the throttling loss that takes place in the ordinary globe or angle valve.

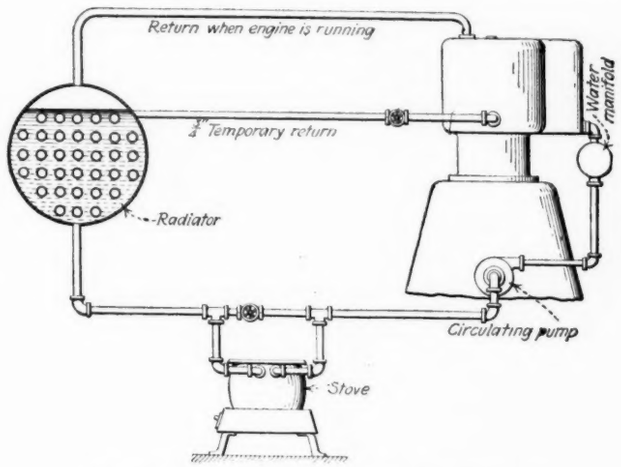
This idea would seem to lend itself to wide application in the design of valves. For instance, if the throttling drop through the inlet and governing valves of engines and turbines could be reduced, there would result a definite gain in plant efficiency. Another example is the boiler-feed control valves where considerable pressure losses generally occur when the usual design of valve is used.

While considering the question of valve losses, it is in order to suggest that all makes of the better-grade valves used in power plants be studied with the idea of reducing pressure losses through the valve. Some studies that have already been made indicate that there are possibilities of improvement in this direction. All such savings must be reflected in improved plant performance even though the percentages may not be large. What is needed is the application of good hydraulic engineering to our valve designs. The new valve referred to in the opening paragraph is a step in the right direction. A. G. CHRISTIE.

Baltimore, Md.

Holding Portable Boiler Warm Without Firing

With reference to the inquiry of S.W.L. in the Jan. 6 issue, on "Holding Portable Boilers Warm Without Firing," the accompanying illustration shows a method we used on several 125- and 175-hp. four-cylinder marine-type gasoline engines to keep them warm and avoid draining the radiators when not running at night and on Sundays. These engines and radiators have nothing more than wind breaks around them. On the 125-hp. engines a small water-jacketed laundry stove is shunted onto the circulating pump suction from the



Water-jacketed stove maintains circulation

bottom of the radiator and circulates the water through the cylinders and back to the radiator. This simple arrangement has kept these engines and radiators from freezing when the temperature was 25 deg. below zero and warm enough to start easily.

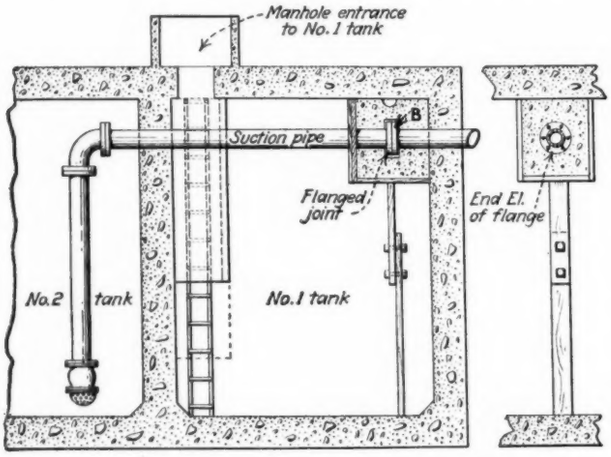
On the 175-hp. engines larger stoves were used, the radiators being large automobile type and vertical, which permitted the return pipe leaving the cylinders near the top and entering the top of the radiator just below the water line. It would hardly seem possible to maintain sufficient circulation through a ¾-in. pipe, but it worked very well. W. I. MORGAN.

Powell, Wyo.

Air Leak Due to Cracked Flange Stopped by Incasing Joint in Concrete

With reference to my article entitled "Air Leak Due to Cracked Flange Stopped by Incasing Joint in Concrete," which appeared in the March 17 issue, a few of the important points were apparently omitted in preparing the text for publication.

This particular repair job was a rather hazardous task owing to the dense gas off the oil and a depth of 15 in. of oil to wade in at the bottom of the tank. A respirator had to be worn by the men doing the work, which added greatly to the difficulty. Also, the hatch extended downward much farther than shown on the drawing, being only three feet from the bottom, or as



Hatch extended downward close to bottom of tank

indicated by the dotted lines on the drawing reproduced herewith. The fact that the hatch came so near the bottom added greatly to the difficulty of getting the material with which to make the repair, into the tank.

Vancouver, B. C. F. E. BESCOBY.

Will a Broken Discharge Valve in Air Compressors Cause Temperature of Air To Increase?

I was interested in the letter of F. C. Blomberg in the March 24 issue, in which he told how a broken valve of an air compressor caused a fire in a power plant. Unfortunately, there were not sufficient data given to enable me to discuss safely the entire occurrence. It seems, however, that there was an air compressor supplying compressed air for some air lifts and incidentally for elevating lubricating oil to a tank overhead for the general supply of a large power plant.

With everything running regularly, a fire suddenly started in the compressed-air system, making the 6-in. header red hot and curving it up by the expansion so that it set fire to the floor beams overhead. The question arose at once as to the cause of the fire. It is evident from the story that too much oil was used in the air cylinder and that there was no inspection of the interior of the receiver or piping, or there would not have been a ¼-in. deposit of highly combustible material in the pipe, and no less in the valve surroundings and in the air passages of the cylinder head.

Such fires as this were a familiar occurrence in air-compressor practice forty years ago. During the construction of the Croton Aqueduct in the eighty's the air receivers would get red hot, but no serious accidents resulted. The accumulation of the oil residuum was regarded as more or less inevitable. In examining the compressor a broken discharge valve was found, and then someone, who has not claimed the honor of it, invented the ingenious theory that the cause of the trouble was the broken discharge valve, allowing the air to leak back into the cylinder and be recompressed a number of times, until the temperature reached the ignition point of the oil in the compression cylinder.

I have never seen any explanation of how this theory works in practice, for in my opinion no explanation is possible. In this case the compressor was apparently working all right, and there was no complaint of any appreciable diminution in the volume of air being delivered, which means that the cylinder was nearly filled to its full capacity at each stroke with new air, and for this to occur it would be necessary for the pressure of the air remaining in the cylinder on the return stroke to fall somewhat below that of the atmosphere. As the pressure in the cylinder falls quickly at the beginning of the return stroke, the volume of compressed air escaping backward past the broken valve would be small, and the temperature of even this small portion would fall with its re-expansion. When the end of the return, or intake stroke was reached and compression began again, the small amount of compressed air which is assumed to have escaped backward past the broken valve, now re-expanded, would be compressed again with the rest of the air in the cylinder and driven forward mixed with the mass of new air and carried along into the discharge.

It might be noted that while the amount of compressed air used in the world has increased a thousandfold within half a century, and the number of compressors employed has multiplied many times, fires within the compressing apparatus and its connections, or destructive explosions, are now of rare occurrence, because the apparatus is operated more intelligently and the contributive causes have been eliminated. Stage compression with intercoolers and aftercoolers, a sparing use of selected lubricating oils and systematic inspection, cleaning and adjusting of the entire apparatus, have practically eliminated the dangers, and now when accidents of this kind occur, someone is to blame. The cause will not be primarily in broken or sticking or leaky discharge valves, except as they are the results or the accompaniments of the general demoralization.

Doubtless more plausible theories might be devised to account for the sudden kindling of these fires when the combustible material has been deposited upon the surfaces which are destined to be burnt over and all the contributive conditions are favorable. A noticeable feature in these fires is the rapidity and intensity of the combustion when the fire has actually started and as long as the compressor continues to run. It is to be remembered that when the air is compressed to, say, six or seven atmospheres, there is six or seven times the quantity of oxygen present in any given volume of the compressed air, and that sufficiently accounts for it. If, then, the presence of this excess of oxygen so accelerates the combustion when the fire has actually started, might it not also have an equal accelerating effect in the starting of the fire or in lowering and making more responsive the point of spontaneous ignition? This suggests a new line of experimenting.

Plainfield, N. J. FRANK RICHARDS.

Questions and Answers

Conducted by

Franklin Van Winkle

Removal of Slag from Walls of Oil-Burning Furnace

What is the best method of removing slag formed on furnace walls of oil-fired boilers preparatory to the use of a refractory gun for coating the walls? G. F. S.

When the slag is of considerable thickness, it must be chipped off with a point chisel or a short-handled pick. When the slag covering is thin or has been nearly removed by chipping, the wall surfaces can be cleaned down and prepared for the refractory coating with the regular refractory gun used as a sand blast.

Eccentric Piston Rings

What advantage has the eccentric piston ring over one that is bored concentric with uniform thickness? A. L. C.

The eccentric or crescent shape gives a more uniform pressure against the cylinder walls when the ring is cut and collapsed to a smaller diameter. By the gradual reduction of thickness toward the cut ends, their radial stiffness is reduced, and when greater uniformity of bearing against the cylinder walls is desired in an eccentric ring, it is more easily obtained by peening than by similar treatment of a ring of uniform thickness.

Speeds of Single and Multi-Stage Turbines

Is a single-stage turbine run at a higher rotative speed than a multi-stage? What are the mechanical reasons for adding stages? G. J.

A single-stage turbine is not necessarily built for a higher rotative speed than a multi-stage. A single-stage, single-bucket-row turbine must operate at about twice the blade speed of a four-stage impulse machine if built for the same steam and exhaust pressures. If these pressures are near enough together so that a commercial vane speed such as 800 ft.-sec. can be employed in the single-stage machine, then the four-stage turbine can be constructed for a vane speed of about 400 ft.-sec. This can be accomplished at an equal rotative speed by reducing the disk diameters or, if the wheel diameters are unchanged, by utilizing one-half the rotative speed of the single-stage turbine. Single-pressure-stage impulse turbines containing but one nozzle may be built for low speeds by using more than one row of moving blades. Steam can be re-directed by stationary vanes and passed through the moving vanes in sufficient number to use up the steam velocity.

Multi-stage turbines, particularly in medium and large capacities, are more economical in the use of steam than single-stage units at equal rotative speeds. Single-row stages are inherently more efficient than two- or three-row stages, lower steam speeds ordinarily result in less nozzle and blade friction, while smaller disk diameters greatly reduce disk friction.

Proximate Analysis Compared with Ultimate Analysis of Coal

In determining the heat value of a fuel, why is not the proximate analysis as reliable as the ultimate analysis? R. A. S. E.

The proximate analysis gives the proportion of fixed carbon, volatile combustible, moisture and ash, and affords information as to the characteristics of the fuel and relative value. But the heat value cannot be as accurately computed from the proximate analysis as from the ultimate analysis, since the volatile content varies widely in composition and heat value.

Expansion of Copper Cylinder

A hollow copper cylinder is heated by the application of 7,000 B.t.u. If the cylinder's outside diameter is 10 in., inside diameter 9¼ in., and length is 6 ft., what will be its expansion in length and how much larger will the outside diameter be increased? G. M.

A cylinder 9¼ in. inside diameter, 10 in. outside diameter, and 6 ft., or 72 in. long, would have a cross-sectional area of bore $= 9\frac{1}{4} \times 9\frac{1}{4} \times 0.7854 = 67.201$ sq.in. The area of a circle whose diameter is 10 in. would be $10 \times 10 \times 0.7854 = 78.54$ sq.in. Hence the cross-sectional area of the material would be $78.54 - 67.201 = 11.339$ sq.in.; and as the length is 72 in., there would be $11.339 \times 72 = 816.408$ cu.in. A cubic inch of copper weighs 0.3195 lb., hence the weight would be $816.408 \times 0.3195 = 260.84$ lb. If this weight of copper receives 7,000 B.t.u., each pound would receive $7{,}000 \div 260.84 = 26.84$ B.t.u. The specific heat of copper is 0.0951 B.t.u. per pound per deg. F., and if the cylinder is uniformly heated by the addition of 26.84 B.t.u. per pound, the rise of temperature would be $26.84 \div 0.0951 = 282.2$ deg. F.

For 1 deg. F. increase of temperature copper expands 0.00000887 times any linear dimension, and therefore the length of the cylinder would be increased $72 \times 0.00000887 \times 282.2 = 0.18$ in., and the outside diameter will be $10 \times 0.00000887 \times 282.24 = 0.025$ in. larger.

Loop Due to Late Admission of Steam

What causes the loop BC in the diagram (Fig. 1) from the crank end of our Corliss engine; and how can the valve setting be corrected? A. C. L.

The loop results from late opening of the steam admission valve. The exhaust valve of the crank end closes at *A*, and compression is shown from *A* to *B* during the remainder of the stroke. Reversal in the direction of curvature indicates leakage of the exhaust valve. In the beginning of the return stroke, re-expansion of the compressed steam occurs with a drop in pressure from *B* to *C*, as illustrated by B_1C_1 Fig. 2. If there were no lowering of pressure from leakage or

condensation, the re-expansion would be shown by return of the penoil on the compression line *AB*. For a stroke from the crank end the steam admission valve finally opens at *C* with late admission and rising pressure from *C* to *D* in the beginning of admission, with a sloping admission line as illustrated by C_1D_1 in Fig. 2. To remove the loop, adjust the length of the valve rod that connects the wristplate with the steam admission valve arm of the crank end so the lead will be prompt

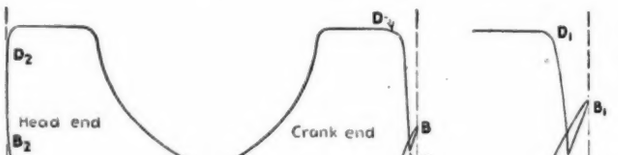


Fig. 1 Fig. 2

Loop BC due to late admission

enough to obtain a vertical line like D_2D_2 of the diagram from the head end, and equalize the cutoffs by adjustment of the governor reach rod to the crank end.

Wrong Length of Hook Rod Gives Apparent Inequality of Laps for Equal Leads

When our 14x36-in. Corliss engine has the steam valves set for equal leads, one of the steam valves has ⅛ in. more lap than the other when the wristplate is on the center. Will this have any appreciable effect on the speed of the engine? *F. C. H.*

If the governor reach rods can be adjusted to obtain equal cutoffs for the average load, there should be no appreciable interference with speed regulation. However, there will be greater variation in equality of cutoffs for variations from the governor position which gives equal cutoffs, due to unsymmetrical adjustment of the valve gear. When leads are made equal, the difference of laps when the wristplate is at the central mark is mainly due to improper length of the eccentric rod or hook rod. Adjust the length of the eccentric rod so the rocker arm will carry the center of the hook-rod pin the same distance on each side of a plumb line through the center of the main rocker pin; next adjust the length of the hook rod so the central mark on the wristplate will be carried the same distance on each side of the central mark on the wristplate hub for a complete revolution or more of the engine. Then, if the leads are equalized by adjusting the steam-valve rods, it will be found that the laps of the steam valves are practically equal when the wristplate is in central position.

Power Transmitted by Leather Belting

What is a good rule for determining suitable widths for main leather belts and for approximately estimating what power a given belt should be expected to transmit? *R. N. B.*

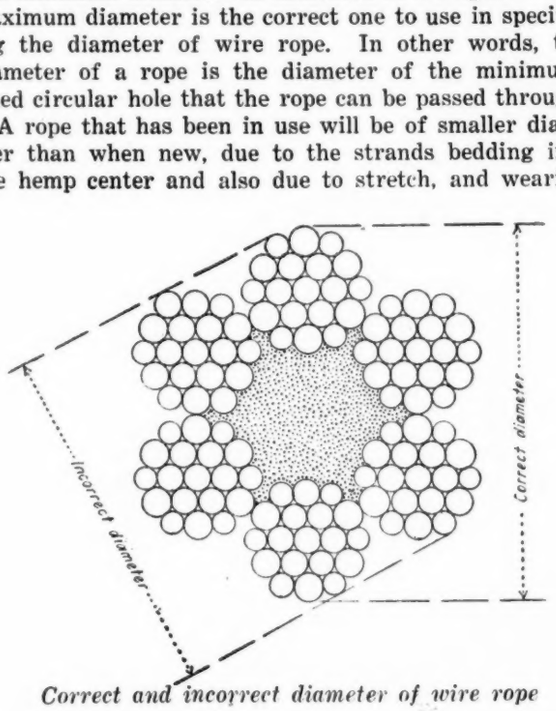
The old rule for determining belt width was to allow 1 in. width of single leather belting and ½ in. width for double leather belting for transmission of 1 hp. per 1,000 ft. of travel of belt per minute. Many designers allow as little as 500 ft. per min., but when constantly used to that capacity with sufficient tension to prevent slippage on iron-faced pulleys, the life of the belt is less than generally demanded. Leather belts of average quality running on iron-faced pulleys are found to have an economic durability when the tension is sufficient to obtain 1 hp. per inch width of single belt and about 1.8 hp. for double belts, for a speed of 700 to 800 ft. per min. As ordinarily put on and maintained, each inch width of good-quality single leather belt may be depended upon for the transmission of one horsepower when running over a 30-in. diameter pulley making 100 r.p.m. and double belts about 1.80 as much power per inch of width. This would be equivalent to a belt speed of 785 ft. per min. As an example, suppose the size of pulley is 20 in. and the speed 300 r.p.m., then without undue stress on the belt, the load may be $\frac{20 \times 300}{30 \times 100} = 2$ hp. per inch width of single thick leather belt and $2 \times 1.8 = 3.6$ hp. per inch width for a double leather belt.

Measuring the Diameter of Wire Rope

Is the maximum or minimum diameter of a wire rope used as its true diameter? *R. C. M.*

Some types of wire rope are laid up so that their external surface forms almost a true circle, in which case the rope has practically only one diameter. In the rope generally used on elevators, this is not true and there is considerable difference between the maximum and minimum diameters as indicated in the figure. The maximum diameter is the correct one to use in specifying the diameter of wire rope. In other words, the diameter of a rope is the diameter of the minimum-sized circular hole that the rope can be passed through.

A rope that has been in use will be of smaller diameter than when new, due to the strands bedding into the hemp center and also due to stretch, and wearing



Correct and incorrect diameter of wire rope

of the strands. The sizes of hoisting ropes between 2 in. and ⅝ in. in diameter generally are in steps of ⅛ in. If the maximum diameter of an old rope was found to be 1⅛ in., this dimension is less than ¾ in. and greater than ⅝, therefore it will be safe to assume that the cable was ¾ in. in diameter when new. Below ⅝ in. steel or iron cable changes in diameter in steps of 1/16 in. In elevator service the sizes expressed in sixteenths of an inch are not used to any great extent. The sizes most commonly used for hoisting purposes are ½ and ⅝ in. in diameter or larger.

New and Improved Equipment

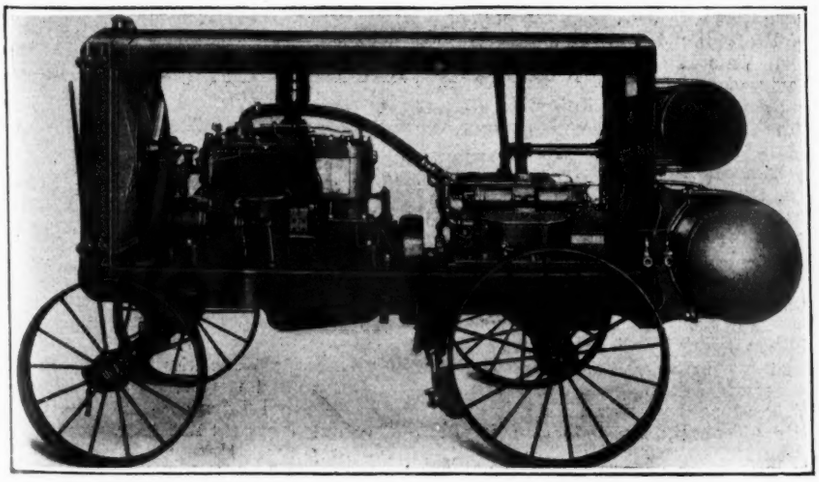
Sullivan Angle-Type Portable Compressor

With the increasing employment, in the larger power plants and the industries, of the portable air compressor for construction and repair work and miscellaneous uses, the new 220-cu.ft. portable compressor just put out by the Sullivan Machinery Co., Chicago, Ill., will be of interest.

In it compressor cylinders have been utilized of the same size as in the 110-cu.ft. portable machine—namely, 5½ in. diameter by 5-in. stroke, single acting—but there are four of these cylinders, and instead of being arranged in a line vertically, they are set in pairs, each pair being at right angles with the other two, forming a "V." Thus each pair of cylinders is at an angle of 45 deg. with the vertical axis of the machine. The 90-deg. arrangement of the pairs of cylinders provides a counterbalancing effect tending to reduce vibration.

Standard "wafer" valves, with short lifts but wide port openings, are used. The general design follows that of the 110-cu.ft. machine. All moving parts run in oil on the splash system. Pistons and connecting rods are of the automobile type. The compressor is directly connected by means of an interlocking external and internal gear clutch to a four-cylinder four-stroke-cycle gasoline engine with reserve capacity over the 43 hp. required for driving at the full rated speed of 800 r.p.m.

The engine and compressor are bolted to a cast-steel frame. The gas and air tanks are suspended in brackets at the compressor end of the rig, the air receiver being 20x60 in. and the fuel tank holding 25 gal. Accessory equipment includes standard portable compressor fittings. Positive circulation is employed to cool the engine and compressor.



View of four-cylinder air compressor of V-type construction

Hollow Metal Balls for Various Uses

The illustration shows the different steps in the process of making hollow balls ("Holbols"), a recent product of the Hollow Ball Co., Inc., Baltimore, Md. The development of this process was brought about through the demand for balls for different types of valves and other services where the solid ball had proved too heavy.

The balls are made from a single piece of metal, cold processing being used throughout manufacture. They are made in two ways, as will be seen from a study of Figs. 1 and 2. In the first method, used for sizes up to ¾ in. in diameter, the raw material is strip metal. This, properly annealed, first undergoes a series of press operations which convert it into a nearly spherical ball with an opening at one point. In the first operation the stock is blanked and the cup is drawn. In the next operation the cup is reduced in diameter, followed by trimming to the correct length. Then the cups are annealed and afterward pointed and rounded into the shape of a ball.

For larger sizes seamless tubing is used, the process of evolution being slightly different, as shown in Fig. 2. The distinctive feature of this process is that the tube is first opened on a radius calculated to compensate for the tendency of the blank to thicken out on the ends during the press operations. From the final press operations the ball emerges uniformly walled and nearly spherical, with two small openings at opposite points of the diameter. These openings are finally closed by placing the balls between the matched grooves of two steel plates of which one is stationary and the other revolves at high speed. Under the action of the revolving plate the balls are given a combined rolling, spinning and gyrating motion under heavy pressure which causes them to contract in volume while the flow of the excess metal accompanied by movement of the metal fibres closes the apertures and makes the walls of the spherical shells uniform in thickness. As the metal is handled cold throughout, the rolling action tends to produce a hard, tough, homogeneous metallic structure. The balls are finally ground and polished.

The balls are made from all standard metals including brass, bronze, copper, Monel, steel and aluminum, and vary from one-half to one-third the weight of solid balls of the same material.

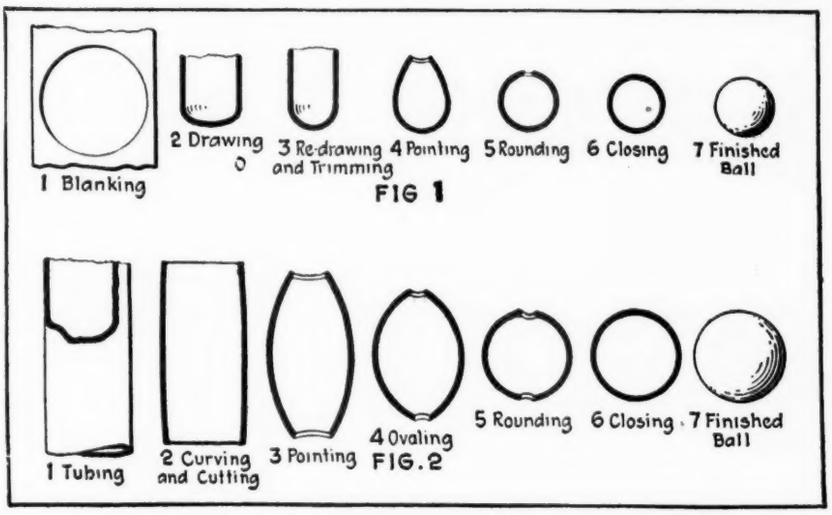


Fig. 1—Evolution of "Holbols" from strip. Fig. 2—Evolution of "Holbols" from tube

A new slant on things observed in and out of the power plant

What Happens and Why?

Would Copper Tubes Transmit More Heat?

LEAVING the questions of strength and cost out of consideration, what would happen if the steel tubes of boilers were replaced by brass or copper. Would heat conduction be materially improved? One might naturally

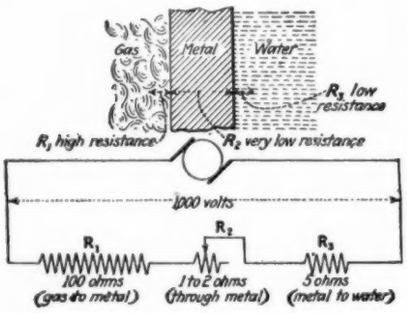


Fig. 1—Metal resistance of little importance in boiler tubes

expect a big improvement, since copper and brass are notably better conductors of heat than iron or steel. This is one of the cases where the "common-sense" hunch is likely to lead one astray. While there would be a slight increase in heat transmission, it would be too small to notice. The same conclusion holds for a steam-filled pipe exposed to the air. With the same surface conditions, the heat loss from a brass or copper pipe would practically be the same as for a steel pipe, particularly in the case of an insulated pipe.

"If this be true," one might ask, "why is brass and copper tubing so much more effective than steel in condensers and heaters, where these materials are used as much on account of their high heat conductivity as because of their resistance to corrosion?" It seems rather peculiar at first glance that the conductivity of the tube metal should make practically no difference in some cases and a lot in others.

To understand these apparent contradictions, it is necessary to study the method by which heat passes from one fluid to another through an intervening wall. In all the cases to be considered the chief methods of transferring heat are conduction[1] and convection.

"Conduction" refers to the heating of one particle by the next, while convection is the actual circulation of a heated fluid. Under normal conditions more heat is transmitted through fluids by convection than by conduction as may easily be shown by preventing circulation of the fluid. For example, when air is trapped between fibers of a wool blanket, the fibers cut down convection to a small figure by preventing general circulation of the heated air, so that practically no heat can pass through except by conduction. The fact that blankets are "warm" proves that convection is the important factor in the case of air at least.

Even water is a poor heat conductor. A test tube of water heated at the top will transmit the heat very slowly to the bottom. Heat applied at the bottom will warm the whole mass of water uniformly, not because "heat rises" as such, but because heated liquids, being lighter, rise to the top and set up violent convection currents.

Heat transfer by conduction may be compared to the flow of current along a wire, while convection is more like

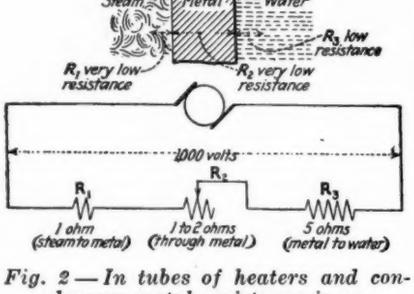


Fig. 2—In tubes of heaters and condensers metal resistance is an important factor

the shipment of charged electrical condensers from one point to another.

The effect of true radiation will be neglected in this discussion, as it is not of much importance at moderate temperatures.

Heat flow is always accompanied by a fall of temperature along the line of flow. This fall is greater for greater flows and greater resistances. The case is analogous to the fall of voltage along a line in which a current is flowing, the fall in voltage increasing with the resistance and the amount of current. In both cases it is the total difference in pressure (voltage or temperature) that causes the flow.

Since it is this difference in temperature that forces the heat to flow through any part of the path, and since the total temperature drop from one end to the other is fixed, increasing the resistance in any section increases the temperature drop there and leaves less temperature drop at all the other parts with a consequent reduction in heat flow.

The whole effect is exactly like that of an electric current flowing through a series of resistances where the voltage on the whole series is constant. A study of a few such circuits will make it clear why copper or brass tubes have a favorable influence on heat transfer in the case of condenser and heater tubes, while they have a negligible effect in the case of boiler tubes (not counting the first few rows) and steam pipes exposed to the air.

Fig. 1 represents a boiler tube with heated gas on one side and water on the other. Three resistances are encountered which fix the flow of heat caused by a given difference in temperature between gas and water. By far the largest of these is the resistance from gas to metal. That from metal to water is smaller and that through the metal smallest of all. Without making any attempt to show exact relative values, the resistances in the corresponding electrical circuits shown below will explain why a change to copper would have little effect on heat transfer.

The gas to metal resistance has been represented by 100 ohms, the resistance through the steel by 2 ohms and that from metal to water by 5 ohms. The total then is $100 + 2 + 5 = 107$ ohms, through which the pressure of 1,000 volts will force $1{,}000 \div 107 = 9.35$

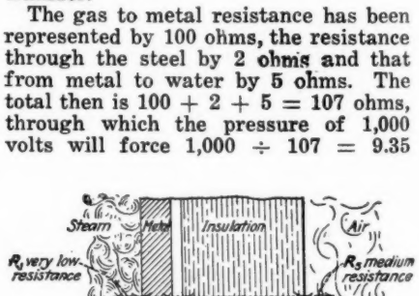


Fig. 3—Heat loss from insulated steam pipes practically independent of pipe material

amperes. If R_2 (representing metal resistance) is cut in half, namely, to 1 ohm, the total resistance will be cut to 106 ohms, which will increase the current only to $1{,}000 \div 106 = 9.44$, a negligible increase.

Next (Fig. 2) substitute steam for gas, cutting R_1 to 1 ohm. This might represent the condition existing in a condenser or a heater. The total resistance of the circuit falls to 8 ohms for steel and 7 for copper. The corresponding currents are 125 amperes and 143 amperes. Here the tube material makes a substantial difference.

Next take the case of an insulated

[1] The first few rows of boiler tubes, it is true, absorb much heat by radiation. These tubes are not considered in the present discussion.

steam pipe as illustrated in Fig. 3. The electrical resistances R_1 to R_5 represent five heat resistances as shown. In R_2 2 ohms represent steel and 1 ohm copper, while for R_4 25 ohms represents thin insulation and 50 ohms thick insulation.

First start with a steel pipe with thin insulation. The total resistance will be $1 + 2 + 5 + 25 + 5 = 38$ ohms, giving 26.3 amperes. Changing to copper will decrease the total resistance to 37 ohms and increase the current to 27 amperes, an unimportant change. But, doubling the insulation will make a decided change. For steel pipe the total will then be $1 + 2 + 5 + 50 + 5 = 63$ ohms and the corresponding current will be 15.9 amperes, a little more than half the flow for the thin insulation.

These observations may be summed up as follows: *A marked decrease in the heat resistance of the metal of a pipe or tube will not show a great increase in heat transfer except where the resistance of the metal is a fairly large fraction of the total resistance in the path over which the heat must flow.*

Application of the Unit System of Pulverized Coal to Boilers*

By Henry B. Jones†

ONE of the notable advantages of the storage system over previous methods of firing has been the great reduction in the amount of machinery so closely tied up with the boiler that any failure therein would necessitate taking the boiler out of service immediately. To secure this same advantage when employing the unit system, it is necessary to have the unit mills so arranged that there are spares available for each boiler. This may be accomplished by the use of two mills per boiler, each mill being of a size sufficient to handle the entire output of the boiler, or it may be accomplished by equipping each boiler with several smaller mills of such size that any one can be taken out of service when necessary without seriously affecting the load carrying capacity of the unit. These requirements tend in the case of larger installations to cause the investment to mount up to figures closely approaching or even surpassing those required for the storage system.

System Has Its Greatest Field in Small Plants

Although there is considerable difference of opinion among proponents of the unit system as to the size of station that can be economically so equipped, it is quite generally agreed that in the case of the plant burning less than 200 tons of coal per day, the unit system has its greatest field. It is quite probable that the exact size of plant in which one would be justified in installing the storage system will be found to vary over a wide range, depending upon local circumstances, which will be peculiar to each problem.

The success of any particular application of the unit system of pulverized coal firing will depend largely upon sound engineering design, not only of the mill itself, but of the connections from the mill to the burner, of the burner, and of the furnace. Experience in this work has made it apparent that there are certain difficulties which will be encountered and which must be recognized in designing any particular installation. These may be enumerated as follows:

First—The difficulty of maintaining uniform proportioning of coal and air over a wide range of boiler capacity.

Second—The division of the coal and air system uniformly to several burners.

Third—The distribution of the flame in the furnace.

The first difficulty mentioned is largely a problem of mill and fan design, but has a direct effect upon the success of the application. This trouble is also influenced by a change in the moisture content of the coal which affects the capacity of the machine while its speed remains constant, and consequently the quantity of air moving through the machine is constant except as it may be regulated by damper adjustment.

Burner Design

It is necessary with mills of the unit type to use a somewhat higher pressure to secure the velocity to carry the coal from the mill and through the piping than is needed to introduce air into the furnace. For this reason, any attempt to handle all the air for combustion through the mill by means of the mill fan results in a considerable power loss and in the necessity for slowing down the velocity of the stream before it enters the furnace. The most generally accepted practice, therefore, is to handle through the mill just sufficient air for removing the fines and transporting them satisfactorily in the piping, due consideration of course being given to the range of capacity over which the mill will have to operate. In the design of the burner the proportion of air introduced to supplement that which carries the coal, is determined, as is the velocity with which these two streams enter the furnace.

The design of the burner may be such as to shorten the flame greatly and permit economy in the size of the furnace. In shortening the flame, temperatures are concentrated, but this creates no difficulty with regard to the burner if it be so designed that its parts are properly cooled by the incoming air. As a general proposition the flame will be shorter when more of the necessary air for combustion is admitted with the coal than if this air is supplied along the flame as it progresses through a long path. This at once suggests the possibility of admitting all the air for combustion with the coal in a pre-mixing burner. Burners of this type undoubtedly have a field in connection with the unit system and have the additional advantage in such installations of tending to overcome any difficulties that may be experienced in getting uniform proportions of air and coal at the mill discharge.

Furnace Design

The design of a furnace for a small boiler should be worked out with just as much care as the design for one for the largest boiler, if satisfactory operating results are to be expected. It is unfortunate that there are not more consulting engineers doing work in the field of the small plant, who thoroughly understand the principles involved in the design of furnaces for pulverized coal. Because of this situation a great deal of this work has devolved upon the manufacturers of pulverized-coal equipment.

Many of the possible installations for unit mills will be under boilers now in service which are set comparatively low and do not permit of the large furnace necessitated by long flame travel. In the larger station the objection to the large furnace is a matter of expense, whereas, in the small installation the necessity for a large furnace will often be the deciding factor in considering the adoption of pulverized coal. As for any powdered-coal furnace the flame must be kept at a proper distance from the wall and the floor of the furnace on which ashes accumulate. These distances will depend upon and vary with the temperature of the flame and the fusing character of the ash, by which is meant, not alone the temperature at which it fuses, but also the iron content of the ash and its tendency to flux with the refractories.

The temperature of the flame will depend upon the rate of combustion—that is, the B.t.u. liberated per unit of time—and on the amount of excess air admitted. The furnace volume is determined by these features and need not exceed that corresponding to a combustion rate of approximately 27,900 B.t.u. per cu.ft. per hour.

The cumbersome water screen, the added expense of which is particularly objectionable in the smaller installation, may be eliminated by a careful design along the lines mentioned in the foregoing except in cases where a low fusing ash is encountered in combination with circumscribing limits, which necessitate flame clearances too small for the required combustion rate.

The problem of furnace design is often one of quickly absorbing the heat of combustion, thereby reducing furnace temperature, and this may be accomplished by any increase in exposure of water-heating furnace to the radiant heat of the flame, whether such surface be in the floor, walls or top of the furnace.

Air-cooled, or hollow, walls may also be employed to advantage with the unit system under proper circumstances. In fact, all the furnace refinements developed in the application of the storage system may be employed with unit systems, though not always under identical circumstances, for those same factors that in a given case justified the installation of a unit system will have a bearing on the determination of just which of these furnace refinements should be adopted.

*Extract of paper read before Metropolitan Section of the American Society of Mechanical Engineers, March 31, 1925.

†Engineer, Fuller-Lehigh Co.

Variable Capacity from Auxiliaries

By G. G. BELL
Manager Power Development, West Penn Power Co.

VARIATION of capacities from power-house auxiliaries is accomplished either by controlling the speed at which the unit operates or by letting it run at a constant speed and throttling the discharge.

With a circulating pump a slight variation in speed is all that is required to control the amount of water discharged. Few working points on the control are necessary, as it is difficult to determine what amount of water passing through the condenser gives the most efficient results.

Variable-Speed Motor for Controlling Circulation Pumps

Of two methods frequently used for controlling circulating pumps, the most common is a variable-speed motor. In some cases pole-changing motors having two speeds, one being approximately 70 per cent of the other, have been installed. This gives approximately four different quantities of water, if duplicate pumps are used, and the operation is slightly more efficient, but the number of different operating speeds is less than with a variable-speed motor.

Nominally, condensate pumps are operated constant speed. There has been a general practice of installing pumps too large for the service. Some operators claim that there is an advantage in keeping the level in the hotwell constant to prevent the entrainment of air in the condensate. If this is advisable, with the new type of condensers a float can be installed to maintain a constant level in the hotwell, either by regulating the speed or by controlling the discharge head of the condensate pump.

For air removal a hydraulic pump must be operated at constant speed to give the best results. The characteristics of the reciprocating type of air pump are such that variable speed does not greatly improve the efficiency. With steam ejectors the number of ejectors in service is regulated so as to provide the right amount of air removal capacity.

The initial motor-driven boiler-feed pumps were either allowed to run constant speed, the swings being taken on steam pumps, or the motor speed was controlled by hand.

Constant-Speed Motor-Driven Pumps at Springdale

Constant-speed motor-driven pumps were installed in the Springdale station and on the discharge of the pump a 6-in. excess-pressure boiler-feed pump regulator was placed, which was to act as a reducing valve and keep the discharge pressure on the pump a constant amount above the steam pressure. The experience with two valves of this type, which were controlled by pistons, was not satisfactory, and as pilot-motor control had been worked out successfully for motors driving the fans and stokers, it was decided to apply the same principle to a balanced throttling valve. This valve was controlled by a small piston similar to those used in the excess-pressure regulators, but instead of controlling the balanced valve, it controlled the current to the pilot motor that opened or closed the valve through a large worm-gear reduction. This arrangement gave absolute control of the position of the valve, and as the rate of movement was slow, there was no danger of the valve's hunting or hammering.

This valve has been perfected, and all the motor-driven boiler-feed pumps for the four units at the Springdale station and for the last two units installed at the Windsor plant are equipped with it. This same regulator is being used for controlling the steam to the steam-driven pumps, and its use is being contemplated to operate the rheostat controlling the current supplied to the motor-driven pumps. This regulator is shown in Fig. 1.

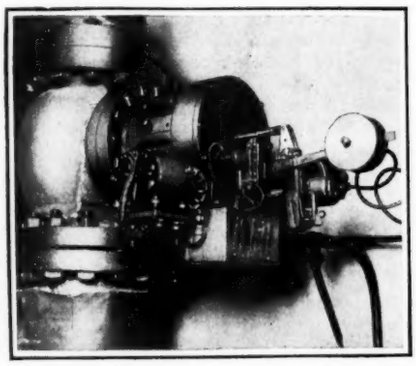


Fig. 1—Motor operated excess-pressure boiler-feed regulator

At the Springdale station the latest boiler-feed pumps are driven by slip-ring motors, the rheostats in the secondary of which are adjusted by hand in accordance with major variations in the load of the unit with which it is operated. The variations below that capacity are taken by the throttling regulator. In case the regulator closes or opens wide, an alarm is sounded to notify the operator. As the load is steady, the loss in efficiency is probably little more than when controlling by the rheostat.

There is probably a reduction in wear and tear on the pump if the discharge pressure is controlled by varying the speed of the motor. Apparatus has been developed which would automatically change the position of the controller on the slip-ring motor, but this has not been used as yet, as the operators are satisfied to make the few adjustments required by hand.

Forced- and induced-draft fans require a speed variation of approximately two to one for normal operation, with provision for such overload rating as may be considered necessary. This variation is not readily attainable with a single slip-ring motor, unless it is of the pole-changing type. Except for the control of furnace pressure, close regulation is not essential.

Induced-Draft Fans Equipped with Two Motors

In the Springdale plant the induced-draft fans are equipped with two motors, the smaller being sufficient to carry up to normal loads, and the larger up to 33 per cent overloaded. This arrangement shows small power losses at normal loads, and compares favorably with results from more expensive motors. In the case of the forced-draft fan, a brush-shifting motor was installed, and to insure reliability of service in case of a burnout of the motor, or trouble with fan bearings, the forced-draft ducts of the various units were interconnected.

It was thought that this brush-shifting motor, which had an indefinite number of operating positions, would give satisfactory results when controlling the furnace pressure automatically, but experience has indicated that variations in furnace pressure are too quick to be successfully controlled by it, and a combination of damper control along with shifting of the brushes, has been required for satisfactory service. This combination of damper control with automatic shifting of the brushes increased the power loss on an average of about 3 kw. per hour, amounting to about 0.03 per cent of the normal boiler capacity.

Automatic control of the induced-draft fans, by varying the resistance of the secondary, gave satisfactory steam-pressure control, normal variations being approximately 5 lb. on a header having a normal pressure of 320 pounds.

The amount of money invested in these special motors and complicated fan controls was large. Tests run to obtain the power consumption of motors operating on damper control only, have led to the opinion that with the coal conditions under which the plant is operating, there is not sufficient saving to justify a large expenditure for expensive control or motors, and that it would pay to put in a slip-ring motor and use a combination of automatic and hand control.

Tests on Fan Motor at the Springdale Station

Fig. 2 shows tests run on a smaller induced-draft fan motor on one of the older boilers at the Springdale station. A comparison of these curves indicates that when producing approximately 160,000 lb. of steam per hour, the power input is the same irrespective of whether the variation in steam output is controlled by a rheostat or by a

*Excerpts from paper delivered before the Chicago Section of the American Society of Mechanical Engineers, Jan. 15, 1925. Other excerpts appeared in the Mar. 3 and April 14 issue of *Power*.

damper. The average power requirements when operating between outputs of 85,000 to 165,000 lb. per hour is 98 kw. when using a damper and 81 kw. when controlling by a rheostat, or a difference of 17 kw. Assuming that the boiler is operated 6,600 hr. a year, this means a loss during the year of 112,200 kw.-hr. With cheap coal this saving on account of the reduction in losses just about pays for the additional expense, while with expensive coal it would justify any additional installation of duplicate motors or other more expensive types of motors which have higher average efficiencies.

To obtain variable speed for stoker and clinker-grinder motors, the most common type of drive is the direct-current motor. These are comparatively small in size and do not require a large motor-generator set to take care

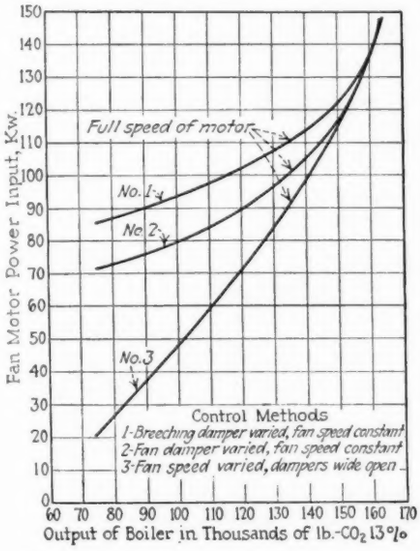

Fan Motor Power Input, Kw.
Full speed of motor
No. 1
No. 2
No. 3
Control Methods
1-Breeching damper varied, fan speed constant
2-Fan damper varied, fan speed constant
3-Fan speed varied, dampers wide open
Output of Boiler in Thousands of lb.-CO2 13%

Fig. 2—Effect of damper control on induced-draft fan power requirements

of the entire requirements of the station.

Alternating-current motors of the pole-changing type with resistance control can be designed to give satisfactory changes in speed, and pole-changing alternating-current motors with mechanical devices are also used with satisfaction.

Starting Equipment

One of the earlier troubles with motors for auxiliary drive was from the starting equipment. The power on the auxiliary bus of the modern large power house was more than standard starting equipment would break successfully in case of trouble. The first step in securing better starting equipment was the introduction of half-voltage starting, which was later followed by motors designed for full-voltage starting, involving the reinforcing of the coils.

Full-voltage starting has the advantage that in case of failure of power and re-establishment of it, the auxiliaries will be restarted automatically. This would be a big advantage in a boiler room where, if the load is thrown off the turbine, it is desirable to reduce the steaming capacity of the boilers as quickly as possible to prevent the loss of distilled water. Starting current amounting to six or seven times normal may or may not be objectionable. When it is objectionable, double-wound squirrel-cage motors can be used. If a variable-speed motor, however, is required, the starting current at the most will not be in excess of two-thirds of what it is for the slip-ring motor.

Selection of Motors

The selection of the type of motor will depend upon the value of power. Practically any kind of motor, when operating near full capacity, has high efficiency. In fact, a squirrel-cage motor has a higher efficiency than a brush-shifting motor at full load. If, then, the simpler type of motor is charged with only the incremental cost of power, for the power losses at part load, the amount of money that can be expended for motors that will give higher average efficiency is considerably reduced. If it is necessary to use dampers to get fine control with either motor- or turbine-driven auxiliaries, the net saving will be even less.

In the cast of a motor that is inefficient at part load, the incremental loss of power would be the average cost of a slight increase in output, the majority of the increase occurring at the lightest loads on the plant. Under such conditions the unit cost would be considerably below the average cost and would probably equal the unit cost of coal.

Responsibility for Boiler Explosions

By A. L. H. Street

There are several decisions of courts of last resort to the effect that mere ignorance by the owner of a steam boiler that it is in defective condition will not exonerate him from liability for an explosion directly due to the defect. Negligent failure to discover the defect will create liability. A case in point was decided by the Michigan Supreme Court (Merryman vs. Hall, 99 Northwestern Reporter, 27).

Plaintiff, a government inspector, while aboard defendant's barge was injured through explosion of a boiler operated on it. He sued for damages and the case went to the Supreme Court three times on appeal before judgment in plaintiff's favor was finally affirmed. That tribunal ruled on the last appeal that there was sufficient evidence to sustain a finding that defendant, though ignorant of the defective condition of the boiler, was negligent in not using proper care, before the boiler exploded, to discover its defective condition.

There was testimony on the part of the defendant that the boiler had been used less than two days since it stood a hydrostatic test of 150 lb. to the square inch. The court said that if this testimony be accepted as true, it conclusively established defendant's freedom from negligence, but added:

"The whole case turns, then, in our judgment, upon the question of whether the court must say that the jury were bound to credit this testimony. These witnesses testify that at the time the hydrostatic test was applied, and for several years prior thereto, there was a gage with a limit of 200 lb. on the boiler, and an expert witness for plaintiff testified that in his judgment the gage was comparatively new and had not been used more than two or three years. We think this evidence, together with the circumstances that the boiler exploded after less than two days' use, with a pressure of less than 100 lb. to the square inch, justified the jury in discrediting the testimony under consideration."

On the preceding appeal (91 Northwestern Reporter, 647) the court reversed judgment in plaintiff's favor and ordered a new trial because of error in refusing to permit defendant to introduce certain evidence tending to show freedom from negligence. The court said:

"The defendant's counsel sought to show that it was not practicable to remove the flues from the boiler for the purpose of ascertaining the condition of the boiler. This testimony was excluded. It may well be doubted whether one who owns a boiler should be expected to remove all of its flues periodically to ascertain whether the braces are defective, and a jury, before passing upon the question, should be allowed to understand the construction of the boiler, and the usual practice among those using similar ones; for the question is whether ordinarily prudent and careful men would do so. If not, it is not negligence to omit it."

On the first appeal (82 Northwestern Reporter, 881) judgment in defendant's favor was reversed because of error of the trial judge in refusing to permit the jury to pass upon a question as to whether or not defendant's fireman was negligent in leaving the boiler unattended for 30 or 40 minutes with the fire unchecked. The court followed the reasoning of the Wisconsin Supreme Court in a previous case where a railway pile-driver boiler exploded:

"The evidence in the case at bar tends to prove that the persons in charge of the boiler and pile driver were culpably negligent in leaving it unattended for more than half an hour. . . . It was certainly for the jury, and not the court, to say, upon the whole evidence, whether this act of negligence was the cause of the explosion; and it was also for the jury to say whether it was want of ordinary care on the part of those in charge to leave so dangerous an engine unattended in the immediately vicinity of a place where they knew people would be passing and repassing. . . . We do not say that the plaintiff could recover in this action if the jury should find as a fact that the explosion of the boiler was the result of a defect in the iron of which it was originally made, or because of defects arising out of its use, and which were unknown to the persons in charge at the time of the accident, and were not discoverable by the ordinary inspection given to it; . . . but if they find that the explosion occurred by reason of the negligence of those in charge in permitting the steam to be raised to an unsafe pressure in the boiler, and that the explosion occurred from that cause, then we think the clear weight of authority is in favor of the plaintiff's right to recover."

The Construction of Jointless Steel Smokestacks

ONE of the many power-plant applications of oxyacetylene welding is in the construction of steel flues and smokestacks. The April issue of *Oxy-Acetylene Tips* discusses the method of constructing and erecting such stacks, and describes an all-welded flue and stack recently built for a Western bank building.

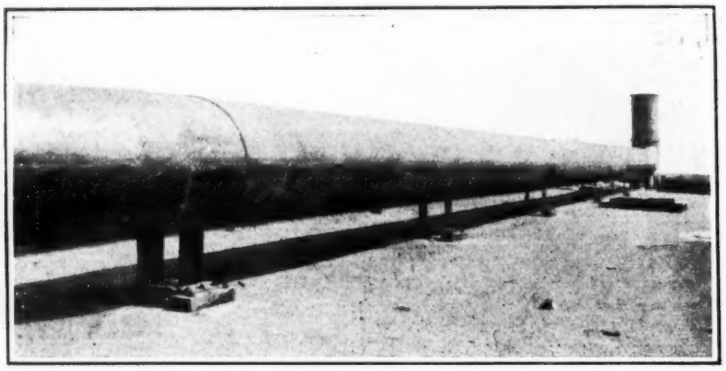


Fig. 1—Horizontal flue 116 ft. long leads to new stack from damper box at base of old stack

The intake for the ventilating system had been located too close to the short smokestack originally erected, and better distribution of smoke was necessary. To accomplish this a horizontal steel tube, 36 in. in diameter, was run from a damper box built at the base of the existing stack, across the roof to the other side of the building, a distance of 116 ft. There it ended in a vertical length about 14 ft. high.

The damper box is about 3 ft. by 3 ft. 6 in., and has a 5-ft. by 5-ft. 6-in. umbrella flange at the bottom, which keeps out rain and still allows expansion and contraction. A damper within the box permits the use of either the new or the old stack, as dictated by atmospheric conditions.

Welding Used for Horizontal Flue

The horizontal flue, made of $\frac{3}{16}$-in. plate, was shop fabricated in three sections, and hoisted to the roof and assembled by welding. It contains two 30-deg. bends to avoid skylights, and one 90-deg. bend to make the vertical turn at the far end. Eight steel-plate saddles were welded on as supports. The total cost of fabricating, erecting and painting was about $1,200.

According to *Oxy-Acetylene Tips* the average welded joint, properly made, runs to about 80 per cent efficiency, as compared with 40 per cent for the average single-riveted joint.

In reference to corrosion it says: "Under normal conditions corrosion in the joints is the most important factor affecting the life of a stack. Smoke from coal or oil almost always contains sulphuric acid. This combines with moisture in the air to form sulphuric acid, which rapidly corrodes steel. Even though a riveted stack is well painted, acidulated water will collect on the edges of the lapped plate and seep into the joints. A welded stack has no joints, cracks, or depression to retain moisture, hence corrosion is avoided and its life is much longer than that of the riveted one. The initial cost, too, of a welded stack compares favorably with that of one built by riveting."

Discussing the construction of welded stacks, the article continues, "All 'oxwelded' stacks are made in about the same way. The plates are first prepared for welding. This consists in beveling the edges if the material is over $\frac{1}{4}$-in. thick and forming the plates. Beveling can be done by machine or with the cutting blow pipe. The latter offers an easy way of doing this and dispenses with the need of a planer. Forming is usually done by passing the sheets through bending rolls.

"The next step consists in welding the horizontal seams. Several cylinders thus completed are lined up on cradles and joined into a continuous stack by welding the circumferential seams. These cradles are usually in the form of a pair of tracks, a large channel or two lines of I-beams laid end to end and secured to the floor. Once the tracks are lined up and anchored in place, the stacks made on them are sure to be straight. Often they are fitted at intervals with rollers, on which the sections can be turned as welding progresses.

Method of Erecting Stack

"Welded steel stacks are readily erected by means of a 'gin pole' (a guyed mast with a block and tackle at the top); or, for a short stack, an 'A' frame can be used. As a matter of fact any support several feet higher than the center of the stack, and strong enough to carry the load, is suitable. No special precautions are necessary in handling a welded stack.

"Steel guy cables are permanently secured to the stack while it is lying on the ground. Then the end of the wire rope from the block at the hoisting support is passed around the stack at a point several feet above the center and firmly secured. As the stack is hoisted, the guy ropes are gradually payed out. When it is finally up-end, the steel guys are used to pull it into position. Then it is bolted to its foundation and the guys permanently secured to ground anchors.

"In all instances where the oxy-acetylene process has been used for stack construction, the result has been a strong corrosion-resisting structure. The life of an ox-welded stack is never governed by the joints—there are no joints. The structure is one continuous cylinder of steel."

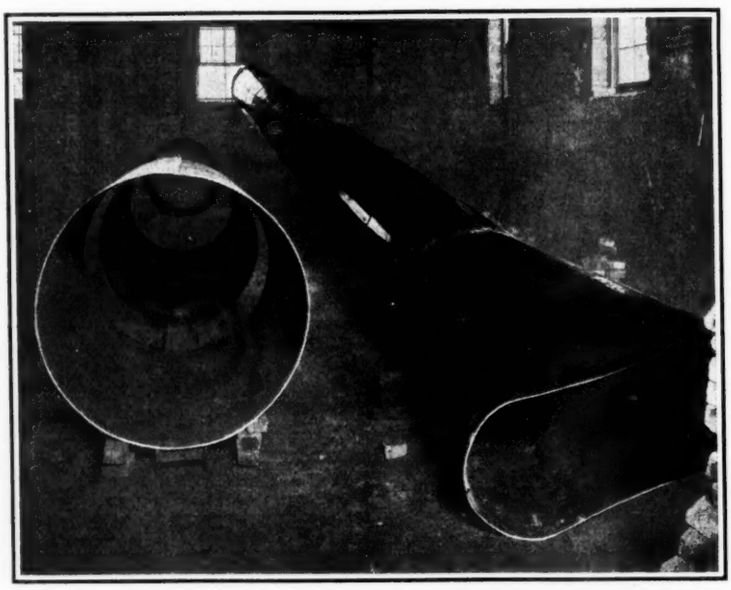


Fig. 2—Sections of stack lined up and welded

Spain Buying More Power-Generating Machinery

Exports of power-generating machinery (omitting electric) from the United States to Spain, increased during the period from January to September, 1924, over the corresponding months of 1923, 35 per cent, without, however, reaching the 1922 figure.

Recent Publications

The Strength of Rotating Disks, with Special Reference to Steam Turbines. By R. Gardner. Published by the Technical Section Association of Engineering and Shipbuilding Draughtsmen, 96 St. George's Square, Westminster, London. Session 1924-25. Paper 5x8 in.; 56 pages; 14 illustrations. Price, 2 shillings (50 cents).

Calculation of proportions for turbine disks is set forth in well-spaced text with plenty of illustrations and examples. Information that otherwise might require reference to several books is presented in concentrated and workable form.

Employees' Representation in Coal Mines. By Ben M. Selekman and Mary Van Kleeck. Published by the Russell Sage Foundation, 130 East 22d St., New York City, 1924. Cloth; 5½x8 in.; 454 pages. Price, $2.

The investigation of the working out of the industrial representation plan of the Colorado Fuel and Iron Co. in its coal mines gives the history of events leading up to the employment of the plan, the plan itself with chapters regarding the plan in practice and in comparison with trade unionism. In the concluding chapter it treats of the plan as an "incomplete experiment."

Combustion in the Power Plant—A Coal Burner's Manual. By Thomas A. Marsh, M. E., Western Engineer, Combustion Engineering Corporation. Published by Combustion Publishing Corporation, 43 Broad St., New York, 1924. Cloth; 5x7½ in.; 255 pages; 63 illustrations. Price $2 net.

The attitude of the author of this book is well illustrated by his refusal to use the term "combustion engineer." With a natural preference for the simplest and most direct English, he uses the term "coal burner" throughout. While this in itself would prove nothing as to the value of the book, it leads one to expect a strictly practical book. Nor is this expectation unrewarded. The chapter on coal is particularly valuable from the practical point of view. Here the author shows what kinds of coal are used in each state of the Union, where they are normally obtained and what is the best way to burn them. The impracticability of buying coal on the B.t.u. basis alone is clearly brought out. The same practical viewpoint is continued in the chapters on combustion stokers, furnaces, boilers, draft, furnace construction, operation, trouble investigations and ash disposal. Of particular interest is the six-page table for trouble shooters, showing where to seek the causes of such difficulties as low capacity, low efficiency, smoke, hot grates, weak ignition, high flue temperature, coke in ash, low CO_2, hot furnace side walls, low draft, etc. This book is recommended as a thoroughly practical guide for those facing the job of buying coal wisely and burning it intelligently.

Connecting and Testing Direct-Current Machines. By F. A. Annett and A. C. Roe. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York, 1925. Cloth; 6x9 in.; 237 pages; 172 illustrations. Price, $2.50.

In most books written on electrical machinery little has been given on the possibilities of making changes in this equipment for operation under conditions other than those for which it was designed. The first part of this book has been devoted to this subject. It opens with two chapters on types of windings and how to read and lay out winding diagrams. Then comes a chapter on the effects of changing the pitch of armature coils, followed by a chapter on taking rewinding data on armatures. Types of coils and how they are made is the subject of Chapter V.

There are three conditions for which an electrical machine may be reconnected—a change in voltage, a change in speed and a combination of both. To each of these subjects a chapter has been devoted. Changing a series motor to a shunt or a shunt to a series; also changing a motor into a generator or a generator into a motor are subjects treated in two chapters.

One of the outstanding chapters of the book is that dealing with "Figuring a New Winding for an Old Direct-Current Machine." This chapter assumes that not even the name-plate data are available and proceeds to work out the problem of designing a new winding for a series-, a shunt- and a compound-wound machine. The method is based on a table giving the rating and dimensions of 220 commercial machines of standard make; this with other tables has reduced a rather long and complicated problem to one that is comparatively simple. Throughout the book examples have been given in the various chapters, showing how the principles are applied to practical problems.

In Part II, testing direct-current machines for locating faults has been covered in eight chapters. Most books treating this subject have told how to get the test results, but have given little attention to the reasons why the defects produced the effects which they did and why the test gave certain results. In this work the authors present the subject not only from the practical side and show how the tests are made, but the reasons why the tests are made in the way they are and why certain results may be expected are shown by studies of diagrams of standard winding. These studies deal with faults in field windings as well as the armature.

An outstanding feature of the book is the illustration of the winding diagrams. Where in the past winding diagrams have been for the most part shown in single lines, in this book complete pictures of the windings have been made, showing the coils as they are on the core. The treatment has been such as not only to meet the needs of the practical electrical workers, but also to give students of industrial schools a means of obtaining an intimate knowledge of those practical problems involved in the maintenance and operation of electrical machinery.

Mechanical World Year Book, 1925. Published by Emmott & Co. Ltd., 65 King Street, Manchester, England. Cloth; 4x6 in.; 348 pages; 105 illustrations. Price, 35 cents net.

This is the revised edition of a little handbook that is published annually and deals with subjects pertaining to machinery. Over 100 pages are devoted to power-plant equipment, such as steam engines, internal-combustion engines, steam turbines and condensers. Such subjects as properties of metals, structural-steel work, gearing, bearings, piping and pipe fittings are treated of in the remaining part of the book. A great many tables covering a variety of subjects are included, making in all a wealth of information of interest to engineers. New material has been added on surface condensers, steam turbines, internal-combustion engines, structural steel and machinery foundations.

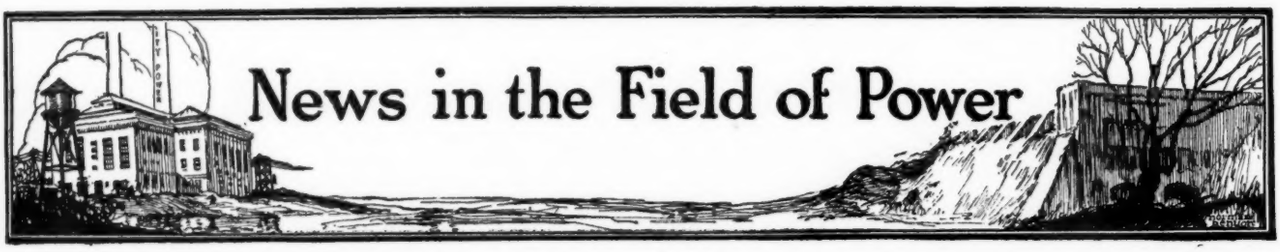
John A. Brashear: The Autobiography of a Man Who Loved the Stars. Edited by W. Lucien Scaife. Published by Houghton Mifflin Co., Cambridge, Mass. Cloth; 6x9 in.; illustrated; 262 pages; price, $4.

A life story such as this, told by a simple kindly man, gives the reader a feeling of being the favored companion of an old friend, during a reminiscent mood, seated in an easy chair before an open fire with time forgotten. It has an intimate quality, yet gives a vivid picture of the period and its leading men in astronomical research and scientific fields. The "Foreword," written by Edna A. Yost, sums up the man, affectionately called by his innumerable friends and acquaintances, "Uncle John," his impulses, ideas and ideals. It makes a fitting introduction to this decidedly refreshing story which will be loved and which will be the inspiration and consolation of many strugglers in the financially unprofitable fields of science and research.

Boiler Feed Water, Supply, Softening and Control in Colliery Practice, by N. Simpkin and A. Dawe. Published by H. F. & G. Witherby, 36 High Holborn, London, W.C. This is Bulletin 16 in a series issued by the Lancashire & Cheshire Coal Research Association on coal and allied subjects. The bulletin is paper covered and the price is two shillings and sixpence net.

The Slide Rule is the title of a 32-page booklet by H. T. Erickson, of the Boys' Technical High School, Milwaukee. It contains a simple explanation of the principle upon which the slide rule operates and illustrated directions for using it. The booklet is published by The Bruce Publishing Co. of Milwaukee. Price, 34 cents.

Manual for Engineers. Published by the University of Tennessee, Knoxville. This small pocket-size book, which gives useful tables and other data for engineers and business men, was compiled by C. E. Ferris. A brief announcement in regard to the university is given in the front of the book. Twenty-sixth edition. Price 75 cents.



Boston Affiliated Societies Hold Annual Dinner

The Affiliated Engineering Societies of Boston held their third annual dinner at the new Chamber of Commerce Building, on April 29. Colonel Gunby was the toastmaster and Brig. Gen. H. M. Lord, director of the United States Budget, spoke on the Federal Budget with his well-known effectiveness. The Affiliated Societies have a membership of nine of the leading engineering associations of Boston. A tenth society is soon to join.

Tyrol To Have Large Hydro Plant

It is reported that the proceeds from the sale of bonds of the Tyrol Hydro-Electric Power Co., a company known as Tiwag, which have recently been put on the market, are to be used for the construction of a large power system in the Tyrol. The plans include the construction of power houses, transmission lines and a pumping station at "Achensee." The project comprises the use of Lake Achen or "Achensee" as a reservoir, and the driving of a tunnel, three miles long through the mountains. It is expected that a head of 1,240 ft. will be produced at the station giving a capacity of 100,000 hp. The power is to serve the Tyrol, Southern Bavaria and northern Italy and to supply energy for the Austrian Federal Railway which is soon to be electrified. The City of Innsbruck is reported to have contracted for power and water and the Austrian Federal Railway for 24,000 hp.

Lakes-to-Gulf Waterway Will Also Be Studied

The President's St. Lawrence Commission, of which Commerce Secretary Hoover is chairman, will function as an advisory board to the American people in their effort to realize the conception of a waterway between the Great Lakes and the sea.

The Commission will study the alternative routes, as well as the St. Lawrence. It is recognized that transportation relief for the Northwest must be secured at the earliest possible time and that there are many uncertainties in connection with the St. Lawrence development which are beyond the control of the United States.

Studies are to be made of the Lakes-to-Hudson route and the Lakes-to-Gulf route. Because of the great expenditure that would be required for the former route and the magnitude of the work involved, study is to be made of the possibilities of the nine-foot project through the Illinois and Mississippi Rivers, as offering a possible route for use in the near future. The Lakes-to-Gulf route lies within the United States.

Says Trade Associations Are Not Persecuted as Charged

Charges that the government in the administration of the anti-trust laws is persecuting trade associations organized for the common benefit of their members were characterized as groundless by E. W. McCullough, Manager of the Department of Manufacture of the Chamber of Commerce of the United States, in an address on April 30, before the Glass Containers Association.

"The Sherman law," said Mr. McCullough, "was enacted nearly 35 years ago and since that time the actual prosecutions brought against trade associations have not averaged one a year. Up until March, 1922, there were exactly 34. When you consider the tremendous increase in the volume of business since the Sherman law was enacted and the really small number of cases which have been brought against trade associations, there are no grounds for charges of persecution.

"Control by agreement, has been a failure ever since the first attempts were made to exercise it in business."

"The nearest I believe we can come to legitimate control, that is restriction which is entirely right and lawful, is that which may be imposed individually through dependable information and intelligence. A business man who actually knows the dividing line between profit and loss will not knowingly sell at a loss, at least for any length of time. Intelligent competitors make the best competition, for it is always the man who doesn't know and is guessing who foments trouble. Therefore, the chief function of a trade association should be the education and information of its members.

"The activities in which trade associations may desire to engage are almost innumerable and the question constantly arises whether or not they may be legal. No department of the government has attempted to enumerate such as they might approve and the only reaction in that direction that business has had is the decisions of the Supreme Court in dealing with specific cases, and in all these instances, judgment has been given not as regards an activity per se, but as related to the circumstances and facts attending each case. Thus, cost accounting, although perfectly legal if conducted solely from an informative or educational standpoint, might, in a particular case, be so related with other activities of doubtful character as to be mentioned in the prohibition imposed by the Court.

"However, until there are amendments offered to change the present anti-Trust laws or until some authoritative agency of the government is empowered to state definitely the legality of the several trade association activities which appear to be desired for them to engage in, it would seem that trouble may be readily avoided if it is borne in mind that our Trust Laws prohibit creation of monopolies, restraints in trade, or interference with equality of opportunity.

"Businessmen meeting in association or informal conference should experience no difficulty in determining whether or not any agreement or understanding they may enter into is legitimate by testing it on this formula.

"The government is not given to prosecution of business organizations on mere technicalities, judging by the past, but on premeditated or wilful violation."

N. Y. State Boiler Inspectors' Salary Bill Vetoed

Governor Smith vetoed the Hackenburg bill outlined in *Power*, April 17, page 553, amending the labor law adding a new section 18-b dividing boiler inspectors into six grades and fixing their compensation on April 23. This bill, it is said, was opposed by certain steam boiler insurance companies.

Southern Exposition To Be Held May 11-23

The Southern Exposition which is to be held in the Grand Central Palace, New York City, May 11-23, will have an extensive exhibit by the Georgia Railway & Power Co., which is one of the large power-generating companies and an important industrial factor of the South. A closer liaison between the North and South is the purpose of the Exposition it is announced. Important industries and natural resources of the thirteen or fourteen Southern States will be shown. Exhibits of the cotton, lumber, brick, clay, fertilizer, coal, oil and minerals, and agricultural developments will be included.

Engineering Council to Back Jones-Wyant Measure

The American Engineering Council Board, which is to meet in Philadelphia May 8-9, will take up the study of the elimination of waste in the administration of the public works function of the United States government, it is announced. Engineers representing more than thirty local and national societies in all parts of the county will attend. The Council proposes to support the Jones-Wyant measure pending in Congress, to reorganize the Department of the Interior with a view of accomplishing greater economies and efficiency. The Council's committee on government reorganization has devised a concrete proposal of departmental organization which, it is believed, meets the demands of sound public policy. This proposal will be discussed at the meeting.

President's Oil Board Wants Information

The President's Oil Board has sent out two letters to leaders of the oil industry, chemists and professors at leading colleges, asking them to submit their views and such material and data as they may have available concerning the "Possible Substitutes for Domestic Well Oil and Products Now Derived From It," and also for information on the Economics of Oil Utilization.

In the letter in regard to "Possible Substitute for Domestic Well Oil and Products now Derived from it," questions are asked regarding the use of alcohol and the possibilities of its production from grains and vegetables, technical difficulties in the use of alcohol and alcohol mixtures for motor-fuel purposes, the use of and production of benzol; information is also sought concerning shale and the production of oil from shale.

The letter on the subject of "Economics of Oil Utilization" takes up the three uses of fuel oil, that is, for steam making, domestic heating and in internal-combustion engines. It asks questions as to the range of gravity of oil sold for burning in steam boiler and industrial furnaces, amounts, price, and in the light of the great promise of the internal-combustion engines using heavier oils, the field open to oil engines where increased dollar efficiency can be expected, and in generating power what over-all efficiencies are obtained in similar work by burning fuel oil to generate steam for use in steam engines and by burning direct in internal-combustion engines.

Muscle Shoals Power Awaits Commission's Action

Acting Secretary of War Davis says that it is the desire of the War Department to co-operate with the Muscle Shoals Commission for the disposition of the power to be developed at Muscle Shoals, and that he will be disposed to wait a reasonable time for any recommendation it may care to submit. The advertisement calling for bids for the power was drafted about a month ago. He stated, however, on April 27, that he had had no indication from the Commission as to when its recommendation will be forthcoming. At the offices of the Commission on April 28, it is stated that no meeting of the Commission had been arranged.

The situation in the Southeast is such that there is much need for additional power. The rainfall during the winter months was 65 per cent of normal. The industrial prosperity of that section has been such during the same period as to call for more than normal supplies of power. As a result the power companies are going into the dry season with little more than 50 per cent of the quantity in their reservoirs that they normally would have at this season of the year. They have been forced to call their steam reserves into action at a much earlier date than usual.

Colonel Spaulding, in charge of the work at Muscle Shoals, has made another trip to Washington. He reports that he is going ahead as rapidly as possible with the construction of the high voltage line from the dam to the steam plant.

The report that the Commission will visit Muscle Shoals in the near future is denied at the Commission's offices. It is understood, however, that Commissioners McClellan and Dial will go to Muscle Shoals in the near future to visualize the properties.

State's Niagara Water Rent Fixed at $60,000

The New York State Water Power Commission yesterday fixed a rental price of $60,000 a year as the state's proper income from diversion of state reserved waters at Niagara Falls by the Niagara Falls Power Co. The case has been before the state power commission for determination since 1921. The Commission also imposed a retroactive rental charge from March, 1922, to January, 1925, of $120,000.

The outgoing Democratic commission last December made a tentative offer to the Niagara company at 50c. per horsepower which would have amounted to about $15,000 a year, with condition that no part of the rental be passed on to the consumer. This offer was not accepted, and the present rental price is fixed without stipulation as to where the money is to come from. Alexander Macdonald, conservation commissioner and chairman of the Water Power Commission, stated recently that the rental had been imposed as provided by statute and that the Public Service Commission is the proper authority to determine if the rental is to be passed along to the consumer in increased rates.

Portland A.S.M.E. Regional Meeting Tentative Program

The tentative program of papers that are to be given at the Portland Regional Meeting of the A.S.M.E., June 22-25 has been announced as follows:

"Latest Developments in High-head Hydraulic Turbines with Special Reference to the Oak Grove Plant," by Ely C. Hutchinson.

"Hydraulic Dredges as Exemplified by the 'Clacksmas.' Latest Type Diesel Electric 30 in. Suction Dredge of the Port of Portland Commission," by Jas. H. Polhemus.

"The Utilization of Wood Waste as Hog Fuel in an Electric Power Plant," by M. S. Bastian. (Symposium to be edited and arranged by Mr. Bastian.)

"The Utilization of Wood Waste by Destructive Distillation for its By-products," by Karl F. Vaughan.

"The Paper Machine as an Application of Engineering Principles," by C. W. Mordon.

"Some Unique Mechanical Features of the Long Bell Lumber Company's Saw Mill at Longview, Washington," by C. A. Huffman.

"Cable Systems on Recent Pacific Coast Logging Developments," by Spencer Miller.

"Electric Logging," by Powers A. Wickes.

"Steam Logging," by Joseph W. Gill.

Numerous and delightful trips are planned to world famous points of interest near Portland, for the visitors.

Gifford-Wood Co. Sells Stock to Employees

The Gifford-Wood Co., engineers, founders, machinists, of Hudson, N. Y., increased its capitalization by the issue of special common stock for the benefit of employees of the company. All the stock thus made available was at once subscribed to by employees, heads of departments and those holding responsible positions. This plan, effective April 1, was adopted by the company in order to allow employees to benefit by their own efforts.

Chicago to Have Annual Power Show

For some time a great many manufacturers of power-plant equipment have felt that a Power Show in Chicago, giving engineers in the great Middle West an opportunity annually to see the latest and best of their equipment would be highly desirable. The thought has been that the new show would supplement rather than interfere in any way with the Power Show already established in New York City, by doubling the opportunity to reach the general field. The time of holding would be set for two months later, giving the opportunity, if desired, to use the same display.

With the foregoing as a background the Midwestern Engineering Exposition, Inc., has been formed with offices at 53 West Jackson Blvd., Chicago, and announcement has been made of the first annual Mid-West Power Show to be held in the American Exposition Palace, Chicago, on Jan. 26-30, inclusive, 1926. The main floor housing the show, 240 ft. wide by 425 ft. long, is conceded to be an excellent place for such purposes.

During the same week a number of engineering meetings of national and local associations will be held in the city, so that the attendance locally and from the Mid-Western territory should be enhanced by the presence of these engineers, who will have the double privilege of attending their own meetings and taking in the show as well.

Peru's Hydro Plants Suffer By Swing of Cold Current

The swing of the Humboldt current from its normal course along the South American coast to somewhere out in the Pacific Ocean has proved a catastrophe to Peru. The climate at Lima has been temperate rather than tropical because of the influence of this cold current. Late in January this cold stream from the Antarctic began to swing out to sea, resulting in a decided rise in temperature all along the coast, lower atmospheric pressure, heavy rainfall along the Andean Ranges, and floods.

These floods have caused a breakdown of all electric light and power service in Lima. The canals carrying water to the hydro-electric plants that supply Lima, Callao and vicinity with current, have been washed out, portions of the plants destroyed and the high transmission lines carried away. Repair work on one small plant which is run by steam generated from crude oil, is being rushed. The lack of current has also stopped the production of ice.

F. L. Ray Enters National Political Arena

Another example of an engineer entering national politics in the interest of better government, is that of Frederick L. Ray of Anderson, Ind., past-president of the N.A.S.E. and a well-known power plant operating man, who has recently entered the national political arena as candidate for Councilman at Large in the Democratic primary which is being held May 5.

A 15-Mile Water Power Tunnel for Scotland

The announcement has been made recently that a contract has been let for a 15-mile rock tunnel, 16 ft. in diameter, to be driven under Ben Nevis Mountain, in Scotland, as part of the Lochaber hydro-electric project of the North British Aluminum Co., described briefly in *Power*, July 22, 1924, page 154. This tunnel will carry the water from two inland lakes to the power house on the coast at Fort William. Its cost is estimated at $8,750,000, while that of the entire project will be nearly $25,000,000, half of which is guaranteed by the government. The engineers are Balfour, Beatty & Co., Edinburgh, Scotland.

Dail Eireann Votes to Develop Shannon

The Dail Eireann, Dublin, passed on April 3, the government bill for developing electric power from the River Shannon, a scheme furnished by the firm of Siemens Schuckert of Germany.

Sir John Griffith, past-president of the Institution of Civil Engineers in London and past-president of the Institution of Civil Engineers in Ireland, adversely critized this action of the Free State Government, according to press reports. He said that Siemens Schuckert had had only six months to study, survey, estimate and report on the Shannon project whereas the Water Power Resources of Ireland Subcommittee had the matter before them for two years and had reported against the immediate development of the Shannon, as a project unsuited to the economic development of Ireland.

Henry Ford Will Enter Wholesale Coal Trade

Henry Ford will engage in the wholesale coal trade in the Northwest, selling through the regular coal distributing channels, according to an announcement made recently. Business will be solicited from regular retail dealers and from large consumers. Orders will be filled from the old Superior Coal & Dock Co. dock at Superior, Wis., which has been leased by the Ford interests.

The statement from the manager of the Minneapolis branch plant is that it is not now the intention to use the Ford organization, but regular coal channels. Where a regular Ford dealer is equipped to handle coal and wishes to do so he may be allowed to. R. O. Eastman is to have charge of the coal department. Administration of coal affairs will be handled from the office of the new plant at the high dam on the Mississippi River, but probably no stocks of coal will be carried there.

Brazil Orders Two Large Waterwheel Generators

Two horizontal waterwheel generators rated at 28,050 kw. each, the largest horizontal units ever made, have been ordered for the Sao Paulo Tramway, Light & Power Co. of Brazil from the International General Electric Co. The generators are rated 33,000-kva., 85 per cent power factor, 360 r.p.m., 11,000 volts, 60 cycles, three-phase. They will be driven by Pelton double overhung waterwheels, operating under a head of about 2,300 ft. In addition to the waterwheel generators the order calls for seven 11,000-kva. 88,000-11,000-volt single-phase 60-cycle water-cooled transformers.

Tentative Program of A.I.E.E. Annual Convention

The American Institute of Electrical Engineers will have papers of interest to *Power* readers at its June 22-26 convention, which is to be held at Saratoga Springs, as follows:

"Engineering and Economic Elements of Two-Phase Five-Wire Distribution," by P. H. Chase, Philadelphia Electric Co.

"Factors Determining Interrupting Capacity and Performance of Oil Circuit Breakers," by E. C. Stone, Duquesne Light Co.

"Current-Limiting Reactors with Fireproof Insulation on the Conductor," by F. H. Kierstead, General Electric Co.

"Two-Phase Six-Phase Transformers," by A. Boyajian, General Electric Co.

"Power Possibilities at Muscle Shoals," by Samuel Wyer, consulting engineer, Columbus, Ohio.

"Hydro-Electric Development of the Saguenay River of Duke-Price Power Co., Ltd., at Isle Maligne, Province of Quebec, Canada," by W. S. Lee, Southern Power Co.

Obituary

Adolphus Otto Backert, editor of the *Iron Trade Review* and general manager of the Penton Publishing Co., died at his home in Cleveland on April 24. Since 1900 Mr. Backert had been connected with technical papers, having been with *The Foundry* and *Iron Age* as well as with the *Iron Trade Review*. He was the author of numerous papers on foundry subjects, usually contributed to the American Foundrymen's Association and other trade associations. His career was a testimony of the opportunity offered by trade journalism for effective service to a specialized industry.

Louis C. Nordmeyer, manager of the A.S.M.E. during 1920-23, and director of the A.S.R.E. 1913-14, died on April 2, after a prolonged illness from pernicious anemia. Mr. Nordmeyer was born in Covington, Ky., in 1869. He supplemented his common school education by attending the public schools, of St. Louis and Washington University. Working as a machinist in St. Louis for two years, he then took up the work of operating engineer in electric-light and power plants. Around the year 1893 he entered refrigerating engineering work as an operator with the East St. Louis Ice & Cold Storage Co., and in 1897 became chief engineer of the Griesedick Artificial Ice Co. In 1900 Mr. Nordmeyer took up the work of designing refrigerating plants entering the employ of the Frick Co. Later, in 1907, when the Tait Engineering Co. was organized, he was made its secretary and treasurer. In 1915 and again in 1917 he went to China to superintend the installation and construction of the first all American industry in China for freezing and drying eggs, returning ill in 1920 and never regained his health. In 1922 he organized, with his son, the Nordmeyer Engineering Co.

George J. Soucy, executive secretary of the Canadian Association of Stationary Engineers, died suddenly of a heart attack on April 12. Mr. Soucy was born in New York City in 1871 and was educated at Troy, N. Y. He started his training at the age of sixteen at the bottom, being fireman, oiler, layout man, machinist and assistant superintendent of the boiler department in turn of the Franklyn Iron Works, Green Island, N. Y. He was appointed superintendent of installation of one of the isolated electric light plants in New York state when he was Twenty-one. The following year he became superintendent of the Eastern Electric Light & S. B. Co., Lowell, Mass., later being offered in 1896 the position of power engineer to the U. S. & C. Co., Troy, N. Y., a position he held for ten years. In 1912 he joined the staff of the Toronto Hydro-Electric System as assistant general superintendent. He was managing engineer of the steam-heating plant of Kitchener, and also was connected with the Dominion Rubber System, Bawden Machine Co. and chief engineer of the power house of the Michigan Central Railroad at St. Thomas. He is survived by a widow, two sons and two daughters.

Society Affairs

The Baltimore Section of the A. S. M. E. will hold a meeting on May 13. R. K. Neade will speak on "Recent Developments in Pulverized Coal as Fuel."

The Philadelphia Section of the A.I. & S.E.E., will hold its May 8 meeting at the Lehigh University, preceded by a dinner at the Bethlehem Hotel. "The Application of Electricity to the Iron and Steel Industry," will be the topic presented with lantern slides, by John C. Reed.

The Hartford Section of the A. S. M. E. will hold a joint dinner meeting with the Meriden and New Britain Sections at the Hartford City Club, May 7. The subject will be, "The World's Economic Conditions," by G. A. O'Reiley, Irving National Bank of New York. Dr. W. F. Durand, president of the A. S. M. E., will also address the meeting.

The Virginia Sections of the A. I. E. E., A. S. M. E., A. S. C. E. and A. A. E. will hold a joint meeting May 8-9 at the Virginia Military Institute, Lexington, Va. George S. Anderson will speak on the "Power Development at Niagara Falls—Featuring the Great Story of Niagara, Practical Superpower in the Niagara Zone and Studies Being Made with Reference to Further Diversion at Niagara."

Business Notes

The J. G. White Management Corp. announces the removal of its offices to the Federal Reserve Bank Bldg., 33 Liberty St., New York City.

The Browning Crane Co. is the new name adopted by the Browning Co., maker of locomotive cranes and buckets, whose main office is at 16226 Waterloo Road, Cleveland, Ohio.

Archer & Baldwin, Inc., dealers in used steam and electrical power equipment, have moved their offices from 114 Liberty St., New York City, to Bound Brook, N. J., where for a number of years they have had a warehouse.

The Stephan Company, 7016 Euclid Ave., Chicago, Ohio, is the new name chosen for the Hale-Stephan Co. This firm is the Cleveland representative of the Furance Engineering Co., of New York City; the Vulcan Soot Cleaner Co., of DuBois, Pa.; the "S-C" Regulator Manufacturing Co., of Fostoria, Ohio, and the Standard Turbine Corp., of Scio, N. Y.

Jenkins Brothers, makers of valves, sheet packing and rubber gaskets, 80 White St., New York City, have purchased outright the good will, stock and outstanding accounts of the old established firm of H. A. Rogers Co., 87 Walker St., New York City, dealers in railway, mill, mining and contractors' supplies. This firm has been for many years the representative for the "Moncrieff Scotch Gage Glasses;" the "Perth," for standard pressures, and the "Unific" brand for high pressures. This agency will be carried on by Jenkins Brothers, and a complete stock of the glasses will be carried at their offices at: 80 White St., New York City; 524 Atlantic Ave., Boston, Mass.; 133 North Seventh St., Philadelphia, Pa.; 646 Washington Blvd., Chicago, Ill. All other specialties dealt in by the H. A. Rogers Co. will be closed out and discontinued. The company also announces that William A. Tucker, connected with the H. A. Rogers Co., since 1880, will be associated with them.

Trade Catalogs

Generators, Sine Wave — General Electric Co., Schenectady, N. Y. Bulletin No. 42567 describes its sine wave generator used for various testing applications. Beside text, the bulletin contains charts, diagrams, photos and tables.

Ball Bearings—The New Departure Manufacturing Co., Bristol, Conn. Leaflet "You Can Lower the Maintenance Expense of Your Electric Motors" describes and illustrates the use of these ball bearings in motors.

Pyrometers — Republic Flow Meters Co., Chicago, Ill. This new catalog covers the subject of heat measurement and contains exceptionally good illustrations of the pyrometers manufactured by the company. A color temperature scale chart and a number of equivalent charts and tables of melting points and fusion points of cones are included.

Coming Conventions

American Boiler Mfg. Association, H. N. Covell, 7 East 19th Ave., Brooklyn, N. Y. Meeting at Glen Spring Hotel, Watkins, N. Y., June 1-3.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional convention, at Swampscott, Mass., May 7-9. Annual convention at Saratoga Springs, June 22-26.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Traymore Hotel, Atlantic City, June 15-17.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Society of Refrigerating Engineers. William H. Ross, 35 Warren St., New York City. Convention at Milwaukee, May 18-21.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, Pa. R.R. System, Chicago, Ill. Seventeenth Annual Convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Kansas Association** at Topeka, May 6-8. J. M. Van Sant, 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **Illinois Association at Decatur.** Olaf Jacobsen, 837 Lake Side Place, Chicago. June 3-5. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at McAlpin Hotel, New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Southern Exposition—C. F. Roth, Grand Central Palace, New York City. Exposition May 11-23, at Grand Central Palace, New York City. Formerly announced for January.

Gages—Brown Instrument Co., Philadelphia, Pa., "Brown Recording Pressure and Vacuum Gauges" is catalog 74 describing with good illustrations these gages for plants and processes. A list of standard charts is included.

Speed Reduction — Boston Gear Works Sales Co., Norfolk Downs, Mass. "Boston Speed Reduction Units" is a small catalog covering this product of the company. Illustrations and tables of dimensions and prices are contained in the catalog.

Chains—Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill. Book No. 755, "Drop Forged Rivetless Chains for Conveyors and Elevators," contains good illustrations of construction and operation, dimension tables and textual descriptions of this rivetless chain.

Conveyor, Steam Jet — Hahn Engineering Co., Twentieth St. and Indiana Ave., Philadelphia, Pa. A catalog describing this conveyor for ashes, slag, soot, coke and other abrasive materials has just been published. Illustrations show the tapered inserts of corundum in every liner, as well as the arrangement of conveyor as applied to boilers.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	April 27, 1925
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.48
Clearfield	Boston	1.75@ 2.20
Somerset	Boston	1.90@ 2.25
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.35@ 1.50
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.60@ 1.70
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.15@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.00@$3.00
Buckwheat No. 1	Philadelphia	2.00@ 2.75
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—Apr. 30, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Apr. 21, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5.5c. per gal.

Pittsburgh—Apr. 20, f.o.b. local refinery; 30@34 deg. fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Apr. 25, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Philadelphia — Apr. 22, 28@30 deg. $2.31@$2.373 per bbl.; 18@22 deg., $2.184@$2.247; 13@16 deg., $2.06@ $2.123 per bbl.

Boston—Apr. 27, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Apr. 21, tank car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¾c. per gal.; 26@30 deg., 6c. per gal.; 30@32 deg., 6¼c. per gal.

New Plant Construction

Ark., Fort Smith—Sebastian County, T. A. Norris, Judge, will soon award contract for sewage pumping station, at county hospital. Estimated cost $28,000. Equipment, including 250 g.p.m. pump, driven by 15 hp. motor, will be required. W. L. Winters, 311 Merchants National Bank Bldg., is engineer.

Calif., Inglewood—City, O. M. Duelke, Clk., is in the market for a deep well turbine centrifugal pump of enclosed line shaft, capacity of 1,125 g.p.m., against head 165 ft., when operating at a speed of 950 to 975 r.p.m. with 440 v. electric motor.

Calif., Los Angeles—Tifal & O'Connor, 709 Grant Bldg., are having plans prepared for the construction of an 8-story apartment, including steam heating and refrigerating system, 2 electric elevators, etc., on southwest corner of Normandie Ave. Estimated cost $1,000,000. Private plans.

Calif., Manteca—South San Joaquin Irrigation Dist., Manteca, and the Oakdale Irrigation District, Oakdale, plan an election May 8, to vote $1,100,000, each, for the construction of Melones dam, reservoir, etc. Plans include a $25,000 pumping plant. A. J. Wiley, Boise, Idaho, is consulting engineer.

Calif., Merced—Merced Irrigation Dist., H. P. Sargent, Secy., will receive bids until June 2, for spillway gates and equipment, including centrifugal pump, 2 hydraulic ejectors and 1 high pressure oil pumping system for Exchequer dam and power plant.

Calif., Oakland — County of Alameda, awarded contract for the construction of a powerhouse, at county hospital here, to J. Branagh, 184 Perry St., $153,000.

Calif., Wilmington — Harbor Ice Co., awarded contract for the construction of an ice manufacturing plant on Lagoon Ave., to R. E. Campbell, 302 East Anaheim St., Long Beach, $42,000.

Ga., Macon—City plans the construction of a 2,500,000 gal. reservoir, will also install new boiler and pump at Riverside station.

Ill., Chicago—C. F. Henry, 7455 Greenview Ave., will build a 5 story apartment house on Ainslie St. Estimated cost $650,000. Owner is receiving bids on separate contracts. R. France, 155 West Clark St., is architect.

Ill., Chicago—Martha Wilson Memorial Hospital, 735 Fullerton St, will soon award contract for the construction of a 5 story hospital, on Fullerton St. Estimated cost $800,000. Holabird and Riche, 104 South Michigan Ave. are engineers and architects.

Ill., Chicago—Wesley Memorial Hospital, 2449 South Dearborn St., is having plans prepared for the construction of a 5-story hospital on Superior St. Estimated cost $750,000. Holabird & Riche, 104 South Michigan Ave., are engineers and architects.

Ill., South Pekin—City plans the construction of a water pumping station, elevated tank and distribution system. Estimated cost $60,000. Holbrook, Warren and Van Praag, 416 Millikin Bldg., Decatur, are consulting engineers.

Ind., Terre Haute—Shrourds-Stoner Co., 510 Tribune Bldg., Archts. and Engrs., will receive bids until May 8 for the construction of a one unit of produce commission market, including boiler and engine room, pump house with deep well, etc., for the Wadley Co., First and Poplar Sts. Estimated cost $160,000. Equipment, including a 200 hp. high pressure boiler, will be purchased. Contract for market building, including cold storage plant, etc., was awarded to Roeham Bros., 5th and Cherry Sts. Estimated cost $160,000.

Ind., Terre Haute—Shourds-Stoner Co., 510 Tribune Bldg., Archts. and Engrs., will receive bids about May 15th for the construction of group of buildings including boiler house, etc., for T. H. I. & E. Traction Co., 725 Wabash Ave. Estimated cost $90,000. W. F. Graves, is chief engineer.

La., Donaldsonville—Light and Water Commission will receive bids until May 13 for the construction of a new filtration plant. Pumping equipment, electrically driven, will be required. Estimated cost $50,000. J. W. Billingsley, Interstate Bank Bldg., New Orleans, is engineer.

Md., Baltimore—Standard Electric Machinery Co., 9 East Hill St., is in the market for 125 v.; d.c. generator; 220 v., 3 ph. 60 cy., slip ring motor; drum starter, and d.c. generator panel.

Mass., Amherst—Amherst College, G. D. Olds, Pres., plans the construction of a central heating plant. Estimated cost $75,000. Engineer not selected.

Mass., Lexington—W. A. Young, is in the market for 4 ton ice machine.

Mass., Northampton—Northampton Gas & Electric Co., awarded contract for a 3 story plant addition to J. R. Wennergren, Florence. Estimated cost $40,000.

Minn., Minneapolis — Bd. of Education, 305 City Hall, G. F. Womrath, Business Supt., will receive bids until May 8th for refrigeration machinery for new high school at 49th St. and Wentworth Ave.

Mo., Ash Grove—City having plans prepared for the construction of a waterworks system, including pumping equipment. Alexander Engineering Co., 517 Woodruff Bldg., Springfield, is engineer.

Mo., Kansas City—C. A. Smith, Archt., 800 Finance Bldg., will receive bids until May 7th for the construction of a high school including a separate power plant for Bd. of Education. Estimated cost $400,000.

Mo., St. Louis—E. M. Worthington, 535 Belt Ave., will soon take bids for the construction of a 9 story, apartment house, at 4166-68 Lindell Blvd. Estimated cost $750,000. W. S. Frank, Century Bldg., is architect.

N. J., Ridgewood—Village Commissioners, will receive bids until May 19, for deep well and pumping system, for new water supply. E. J. Fort is village engineer.

N. Mex., Silver City—City voted $300,000 bonds for construction of waterworks system, including pumping equipment, etc. Engineer not selected.

N. Y., Lackawanna—City, N. A. Hegedus, Clk., Council Chamber, City Hall, will receive bids until May 9, for the construction of a sewage disposal plant and pumping station, F. K. Wing, 1314 Prudential Bldg., Buffalo, is engineer.

N. Y., New York—S. Barkin, 565 5th Ave., plans the construction of a 15-story loft building on West 48th St. Estimated cost $2,000,000. Engineer and architect not selected.

N. Y., New York—Department of Public Markets, Municipal Bldg., awarded contract for the construction of a refrigeration power house, for the Bronx Terminal Market, Exterior and East 151st St., to W. W. Construction Co., 15 West 40th St., $284,290.

N. Y., New York—The Garment Workers' Union, M. Sigman, Pres., 3 West 16th St., is having plans prepared for the construction of a 5 story apartment, including steam heating system, at 158th St. and Sheridan Ave. Estimated cost $1,500,000. A. J. Thomas, 15 East 47th St., is architect.

N. Y., New York—J. T. Lee, 25 West 43rd St., awarded contract for the construction of an office building at 5th Ave. and 41st St., to Rheinstein & Hass, 21 West 40th St. Estimated cost $5,000,000. Starrett & Van Vleck, 8 West 40th St., Engrs. and Archts., will award contract for steam heating system, etc.

N. Y., New York—Seaman's Bank of Savings, Wall St., is having plans prepared for the construction of bank and office building, including steam heating system, at Wall and Pearl Sts. Estimated cost $5,000,000. B. W. Morris, 101 Park Ave., is architect and engineer.

Okla., Bristow—City plans a deep well water supply with pumping equipment. Estimated cost $45,000. Engineer not selected.

Okla., Hinton—City is having preliminary plans prepared for improvements to electric light plant, including the installation of dynamos, etc. Estimated cost $30,000. Benham Engineering Co., 512 Gunbel Bldg., Kansas City, Mo., is engineer.

Okla., Thomas—N. B. Gardiner, Sentinel, plans the construction of a cotton gin here. Machinery, including a 150 hp. motor, will be purchased. Private plans.

Okla., Wewoka—City, J. R. Fraser, Clk., plans an election to vote $200,000 bonds for waterworks improvements, including pumping unit, etc. Engineer not selected.

Ore., Eugene — City Commissioners will receive bids about July 1, for waterworks improvements, including an auxiliary pumping plant, etc., on the McKenzie River, here. Estimated cost $600,000. Auxiliary pump for high line, probably electrically driven, will be purchased. C. A. McClain is superintendent of Water Board.

Ore., West Linn — Crown Williamette Paper Co., Pittock Bldg., Portland, awarded contract for the construction of a paper mill on the Williamette River, to A. Guthrie & Co., Sherlock Bldg., Portland. Owner will purchase machinery including boilers, engines, etc., for 100 ton mill. Estimated cost $200,000. Company engineers in charge.

Pa., Ardmore—Bd. of Township Comrs., Lower Merion Township, G. C. Anderson, Secy., will receive bids until May 14, for sewage pump and motor, for Mill creek sewage pumping station. Mebus & Albright, 1502 Locust Pl., Philadelphia, are engineers.

Pa., Doylestown—Bucks County Commissioners will receive bids until May 11, for the installation of a steam heating plant in court house here.

Pa., Philadelphia — Schletter & Zander, Kensington and M Sts., awarded contract for the construction of a hosiery mill, including power house, at Levick and Keystone Sts., to W. Steele & Sons, 219 North Broad St.

Pa., Philadelphia—D. Weber & Co., 5th and Locust Sts., awarded contract for the construction of a factory, including boiler house, at Tioga and Richmond Sts., to Robbins Construction Co., 1137 North Front St.

Pa., Philadelphia—J. Zimmerman & Sons, 221 Lehigh St., awarded contract for the construction of a plant including power house at Torresdale Ave. and N St., to W. Steele & Sons, 219 North Broad St.

Tenn., Humboldt—City voted $75,000 bonds for improvements to municipal power plant.

Tenn., Memphis—Shelby County, E. W. Hale, Chn., voted $500,000 bonds for the construction of county hospital, here.

Tex., Big Springs—City, J. M. Middleton, Secy., voted $30,000 bonds for extension to waterworks system, including mains, pumps, etc.

Tex., Clarksville—Clarksville Gin and Seed Co. will soon take bids for two 150 hp. engines, etc., also plans to install electric motors in plant.

Tex., Dallas—E. A. Kingsley, City Engr., will soon receive bids for the construction of a sewage pump station on Birmingham St., South Dallas. Estimated cost $70,000.

Tex., Idalou—City plans an election to vote $40,000 bonds for waterworks improvements, including mains, pumping equipment, etc.

Tex., San Antonio — Pruitt Commission Co., 1102 West Commerce St., plans the construction of a cold storage plant. Estimated cost $15,000. Machinery will be purchased. Private plans.

Tex., Taft—Pierce Petroleum Co., 305 South Medina St., San Antonio, will soon receive bids for several 50,000 gal. storage tanks, pumping unit equipment, etc. Estimated cost $160,000.

Wis., De Pere—Bd. of Water Commissioners, M. J. Maes, Secy., will receive bids until May 7th for the construction of a pumping station, including 100 g.p.m., motor driven, centrifugal pump with automatic starter and switchboard. W. J. Kichoffer, 22 North Carroll St., Madison, is engineer.

Wis., Watertown—A. Kuenzi, Archt., 202 North Water St., is receiving bids until May 8th for the construction of a plant including boiler house, for Watertown Milk Producers' Association, J. Schumann, Secy., Route 2.

Ont., Port Colborne—Belle Telephone Co., A. C. Price, Mgr., plans the installation of a central energy system, and new cables. Estimated cost $50,000.

Ont., Hamilton—City plans a sewer system, including electric pumps. Estimated cost $51,000. W. L. McFaul, City Hall, is city engineer.